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# THE FOUNDATIONS OF THE AMERICAN IRON INDUSTRY.

*By Archer Brown.*

The whole of modern engineering is dependent on iron and steel—directly, on the constructional side, and indirectly this involves the whole. The enormous expansion of engineering industries during the past decade has been paralleled by a nearly proportionate expansion in the production of iron; but with the tendency of demand represented by a rapidly rising curve, anxious questions naturally present themselves as to the future of supplies. To the general answer of these questions Mr. Brown brings a remarkably comprehensive practical knowledge of the American iron-trade—especially the initial sources of supply, the conditions of successful iron production, and current or coming events in the iron and steel industry. His review is so well-based, therefore, as well as so ably and admirably presented, that it is of the utmost importance. Certain references to politico-economic conditions which seem to the editors to merit fuller comment than is appropriate to an introductory paragraph are treated further on page 105.—THE EDITORS.

THE development of the iron industry of the United States has been marked with surprises. From complete dependence upon the old world the country has leaped to a pre-eminence so complete that even its rivals believe and tremble. In the great railroad-building period of 1870-72 England furnished the rails and other materials at prices two to three times above those which are now deemed abnormally high. Then England produced three times as much iron and steel as the United States. Since then Germany has challenged the supremacy of Great Britain, and passed her in a decade of remarkable growth. And yet, in the current year of 1902, the United States of America will produce more iron than England and Germany combined. Indeed, there is a margin of excess to spare about equal to the product of France. If we add to this statement another fact, viz., that even this vast production is not sufficient for home requirements, and that the United States is today, in spite of a stiff tariff, the best customer in iron and steel that Europe has, credulity is taxed to the limit.

This unparalleled growth has not been without its backsets. The ups and downs of the trade have been so marked as to call from its chief prophet the expression that iron is either a prince or a pauper. Indeed the vicissitudes have been so great, and the ill-starred enterprises so numerous, that capital has always had a peculiar dread of it, and conservative investors have counted it a hazardous field. An industry so vast, so episodical, so filled with promise of still further greatness, and so closely linked with the whole fabric of national material progress, naturally comes in for a full measure of discussion.

What will be its future? Are the wonderful natural resources on which it is built inexhaustible? Is the support of a protective tariff longer needed or desirable? Can American manufacturers hope for a world trade and continue paying to labor double the rates paid by their rivals? Is the enormous home consumption a stable or a temporary factor? Will the consolidation of mines, furnaces, mills, and carrying lines, into great corporations with huge aggregations of capital, help or hinder the broad development of the industry? Can the facilities for the cheap assembling of raw materials, which are the wonder of other nations, be further improved? There is material in these and like inquiries for ample and interesting study.

It is first of all in the vast natural resources of the United States that the industry finds its sure foundation. The basis of all iron and steel making is reliable coking coal and iron ores suited to the Bessemer or the basic process of producing steel. The Connellsville district in Western Pennsylvania carries the largest known seam (9 feet) of high-grade coking coal. But the district is distinctly limited, and at present rate of mining, will be exhausted within a generation. Nature, however, was lavish in providing reserves. The developments of the past ten years among the vast bituminous coal regions of West Virginia, southwestern Virginia, southeastern Kentucky, and eastern Tennessee, have revealed deposits of high-grade coking coal that would seem to be ample to supply the blast furnaces of the world for centuries to come. It is only a question of building railroads, opening mines, and constructing coke ovens. The far-sighted action of the United States Steel Corporation in acquiring and developing a great tract of this coal in the Pocahontas field in order to conserve its Connellsville supply is the most important step yet taken in shifting the base of fuel supply.

Not all good bituminous coal will make coke. Indeed, in all the great coal fields of Ohio, Indiana, Illinois, Missouri, and important coal sections of Tennessee and Kentucky, there has not been found an acre of coking coal. Draw a circle around the Connellsville section in Pennsylvania including the so called "Mountain" operations adjacent on the east; another around the section where Virginia, West Virginia, Kentucky, and Tennessee meet; another around the Warrior coal field in Alabama, and a fourth around a newly developed district in Colorado and Utah, and you have all the known sources of fuel supply for iron and steel making in the United States. It is true that anthracite coal is still used in connection with coke, in the blast furnaces of eastern Pennsylvania, but it is a small and diminishing factor. The circles above indicated, however, embrace deposits so reliable and so extensive that a rate of consumption many times greater than the present could go on for generations without raising the first question of exhaustion.

Though the growth of coke production has been very rapid in the past few years, it has not kept pace with the demand, and the remarkable year of 1902 has witnessed the banking of furnaces for days and weeks because of short fuel supply. As late as 1880 the total coke production was only 3,338,300 tons. In 1890 it had grown to 11,508,021 tons, and in 1901 it reached 21,795,883 tons, of which probably 85 per cent. was used in the smelting of iron ores. Of this total, Pennsylvania produced two-thirds, West Virginia a tenth, and Alabama, Virginia, and Colorado the remainder. The government records show the cost to have been $1.28 per ton in Pennsylvania, $1.88 in Alabama, $1.15 in Colorado, and $1.11 in West Virginia. No other coke in the world approximates the cheapness of cost of the great producing centers in Pennsylvania and West Virginia.

Turning to the other bases of iron and steel manufacture—abundant, suitable, and cheap ores—the foundation seems to be equally secure. There is iron ore in thirty-one states of the Union. Very many of the deposits, however, are unavailable for one or another cause. Thousands of owners of iron lands in Virginia, Tennessee, Alabama, and Georgia, in the south, and in Illinois, Ohio, Wisconsin, and even Pennsylvania, in the north, have had their dreams of wealth dispelled by finding that the ores were too lean, too high in phosphorus or titanic acid or some other injurious element, or were too expensive to mine profitably in competition with the cheaply won deposits in the Lake Superior districts or in the southern States. Even the first miners on the Messabi, the richest of all the upper lake ranges, abandoned their machinery and gave back their lands to the State because the ores were too low in iron to stand long shipment. These pioneers were too far south and west.

There are practically but two processes of making steel in the United States—the Bessemer and the basic open hearth. The former is based on the low-phosphorus ores of the Lake Superior districts, and until the past five years, it had the right of way. More recently, however, the basic process has assumed importance, and its growth has been far more rapid than that of its older rival. Indeed, it may almost be said that Bessemer steel making reached its climax several years ago, and that the recent wonderful growth in steel making has all been in the basic form. This process has the advantage of using the higher-phosphorus ores that are found in many States. The standard specification of basic pig is phosphorus 1 per cent. or under; silicon 1 per cent. or under, and sulphur 0.05 or under, manganese between 0.50 and 2 per cent., the higher preferred. The basic bessemer or Thomas-Gilchrist process, generally used in Germany, and the Siemens-Martin, largely employed in England, have never found root in America.

The supply of low-phosphorus ores for making Bessemer steel was apparently nearer its limitations ten years ago than it is today. The so-called "old range" ores were being mined out at a rate that caused apprehension, and new discoveries were few. The opening of the Messabi district in Minnesota, however, in the decade from 1890 to 1900, changed the situation. The Messabi ores, usually running rich in metallic iron and very low in phosphorus, proved of almost unlimited extent as exploration work went on. Lying near the surface, in great beds from which the earth was easily stripped off, open mining with steam shovels was possible, bringing cost to the lowest point ever reached in the world. Hundreds of thousands of tons have been put on cars at 25 to 30 cents a ton. In Alabama, where the next cheapest mining is done on a large scale, the average cost of putting the red ores on cars is probably 60 cents a ton. But the Alabama ore carries less than 40 per cent. iron, against the Messabi 60 to 65 per cent. These rich beds could be only partially utilized at first, because of the extremely fine or powder-like condition of the ores making it difficult to prevent the strong blast of the furnace from forcing them through the flues or out of the top. Engineering skill, however, has largely overcome this difficulty, and by mixing a small percentage of the old range ores, good results are reached. It might be remarked in passing, that it is in the almost complete ownership of these old range Bessemer ores, essential for mixing, that the United States Steel Corporation comes nearest to control of the situation. Independent Bessemer and non-Bessemer Messabi ores are abundant, and blast furnaces, mill, and lake carrying facilities can be created by the employment of capital. But unless new and extensive deposits of coarse or lump Bessemer ore are found, the grasp of the big corporation on the situation will be a powerful one.

The duration of the supply of Lake Superior ores can only be conjectured. Since the great revival in iron in 1899, exploration work has been carried forward with great energy, and it can safely be said that new sources of supply are opened faster than old ones are worked out. Close to 25,000,000 tons per annum, however, are now being brought down the lakes and this colossal tonnage can not be taken from the ground each year without leaving some tremendous gaps, which nature at present is not engaged in supplying. Some new and considerable deposits have been found in Canada, and the north shore of Lake Superior is known to be rich in iron, although so far as developed, sulphur is found to be present in troublesome quantities. On the whole, it may be said with reasonable certainty that the successors of this generation will not have to curtail their output of Bessemer steel because of exhaustion of the ore supply.

Basic open-hearth steel making would seem to be secure for all time on account of the wide range of ores which can be utilized. The non-Bessemer Lake Superior ores are now most extensively used; next come the high manganiferous ores of Virginia, and lastly the cheaply mined red ores of the Birmingham district in Alabama. In the latter section there has not been the rapid development of basic steel making that has been expected, owing to a variety of causes. In the building of the past two years, the greatest expansion in open-hearth plants has been in eastern Pennsylvania and the central western States. The magnetite and hematite deposits of New Jersey, partially neglected a few years ago, are found to be peculiarly adapted to the making of high-grade steel, and a new and important future is opened for these properties. It is not generally known, perhaps, that one of the largest and most costly blast-furnace plants yet constructed in the United States has gone into operation within a year in New Jersey, within two-hours' ride of New York, and in a district supposed to have been abandoned as an iron-making center.

Before leaving the subject of iron ores, it may be mentioned that very extensive deposits have been explored in sections of the country too remote from the great manufacturing centers to be available for commerce for many years to come. Wyoming, Utah, Washington, and even California, have mountains of high-grade ores, needing only railroads, furnaces, mills, foundries, and an adequate market for the products. All of these will come in time. Texas also has its rich beds of both Bessemer and non-Bessemer ores, but the absence of coking coal and the remoteness of consuming centers will make the development slow. Mexico likewise is rich in ores, but so poor in fuel that for a long time to come the United States and other countries will have to supply the finished iron needed by the sister republic.

The most important deposits of iron ore outside the limits of the United States, which may either be drawn upon for supplying American furnaces or may appear in finished form to compete with the United States, are in Nova Scotia, Cuba, Venezuela, and Spain. Porto Rico, within the political borders of the United States, also has extensive Bessemer deposits. The extensive works lately completed at Cape Breton are now sending about a thousand tons a day to eastern American seaports, about equally divided in form between pig iron and steel billets. The Cuban ores have been used for twenty years as an important source of supply for the leading eastern steel works, but the quantity has increased but little, although energy and capital have been expended liberally in developing what seemed promising properties. The much-talked-of ores of Venezuela are no farther developed than they were at the time of Cleveland's well-remembered proclamation.

The tariff long ago ceased to be a question of vital import to the American iron industry. It needs no argument to prove that, but for the protection afforded by the tariff in the two or three decades following the war, the development of the great resources of the country would have been retarded indefinitely, to the immense advantage of England and Germany. But that period has passed. The infant is a giant. Does it follow that the tariff wall should now be taken down or lowered? The answer varies greatly, according to the point of view, or the school of economic belief of the individual. It is probably within the bounds to say that the attitude of most manufacturers is one of indifference, except as tariff changes might injuriously affect the general business situation, now prosperous to a degree never before witnessed in the United States or any other country. A defender of the protection system has only to point to the unexampled activity of the United States, while her great free trade rival is languishing in business depression, to give his answer. The average manufacturer, untrammeled with theories, and seeking only further extension and greater profits in his own business, and with a vivid recollection of the paralyzing effects upon trade of efforts at tariff revision in the past, says "let well enough alone." The student sees inequalities and inconsistencies that call loudly for correction. The alarmist discovers giant trusts fattening upon the protection given them at the public expense. The western farmer would like to get his barbed wire lower. The railroad president wants to buy his steel rails on the prices afforded by English and German labor. The eastern merchant or structural mill could often buy its billets from abroad cheaper than at home, but for the tariff. The great implement and tool manufacturers of the west, with expanding export trade, want reciprocal arrangements with France and other Continental countries, and are justly bitter towards the small and highly protected industries of cheap jewelry, knit goods, and the like in the eastern States which have succeeded in blocking the reciprocity treaties in the Senate. And so on through the category of varying and conflicting interests.

It is safe to say that the "let well enough alone" policy will prevail, at least while the present prodigious prosperity lasts. The interests that complain are themselves making money so fast that it is hard to work up to the earnestness aand zeal of reformers, and the general public is too busy to lend its ear. The owners of mines and furnaces and mills might reply to the railroad president and the farmer that it is largely because of this great activity in iron and steel that the railroads have a traffic beyond their capacity to handle, and the farmers realize highest prices for great crops and wax rich. They could with justice also add that it will take more than one year of large profits to make up for the years following panic, tariff agitation, and currency discussions, when plants were idle and losses wiped out capital.

As to the prospect for a world trade in American iron and steel products, it must be admitted that two years have wrought a great change, and not in the direction of progress. In 1899 and 1900 American exports of rails, billets, wire, ship plates, and even of pig iron, were on a scale that struck terror to European makers. The United States carried its products to the very centers of production in Great Britain and Germany, underselling them at their doors. Now it is sending abroad nothing but agricultural machinery, machine tools, and sundry highly finished specialties in which American skill finds particular expression. English and German makers have no sooner pulled themselves together and reduced costs to meet the dreaded American competition, than America has withdrawn from the field. Not only that, but she has astonished them by becoming their largest and best customer, permitting them to ride over the tariff wall with three to five shiploads a day of pig iron, billets, structural shapes, plates, etc. What has made this great change? The revival of trade and industry at home. At the height of phenomenal exports, home consumption was still 95 per cent. of the American make. Now it is 105 per cent. The home market is, after all, the overshadowing issue. The United States will deal again with the trade of the world when production once more exceeds consumption. That will not come as soon as anxious rivals on the other side fear, or ultra conservatives at home predict, but it will come. Meantime the depression in England and Continental countries has lowered wages and raw materials, while opposite conditions have heightened the factors of cost in America. Fundamental changes therefore must come before America regains the lost ground on foreign soil.

It is too early yet to measure with any degree of accuracy the influence of the great consolidations upon the future of the American iron and steel industry. Two or three things, however, seem pretty clearly established—and these are contrary to popular notion. The first is that, in the larger lines, there is not, and can not be, any monopoly. Competition will be comparatively free. The smaller manufacturers will multiply. If the big consolidations flourish, they will fatten. Their supplies can not be shut off. They can use the saame materials and processes as their great rivals. Their management will be often of the same high order, for it will come from the men who have created and own their business. The small independent manaufacturer is seldom over-capitalized, seldom mortgaged, and with light fixed charges, he will have a flexibility in the day of trial which will in a large degree offset the powerful advantages possessed by his huge rival in the ownership of raw materials, carrying facilities, the greatest plants, and unlimited working capital. Consolidations will never eliminate competition in the United States.

Another result of the great consolidations, already sufficiently apparent, is the steadying effect upon values. The violent fluctuations of the past, with their disastrous consequences upon all forms of industry, are not likely to recur. The action of the United States Steel Corporation in holding prices within bounds during the stress of excessive demand the past year has no doubt had an influence in prolonging the period of activity. Other makers have seen the wisdom of the policy and, to some extent, adopted it. The real test will come, of course, when demand slackens, and there is not business enough to go around. A conservative policy pursued then by leading makers will quickly adjust supply to demand. The radical one, which has usually been followed in the past, of filling the big mills with work without regard to prices, would provoke a war which would of necessity be hardest on those with the greatest relative fixed charges and outstanding securities. It is safe to assume that, with power centered in fewer and stronger hands than ever before, better counsels would prevail.

There is no more popular belief with respect to the trusts than that they are able to force a higher level of prices at home by selling their surplus abroad at greatly reduced prices. Every man connected with the manufacture of iron and steel knows how complete is this fallacy so far as his own products are concerned. As a matter of fact, for years past the makers of American machinery and other products of iron and steel have, in times of depression at home, realized their best prices in the export business. The moment home demand has become more profitable than the foreign, the latter has been dropped. In the nature of things it can not well be otherwise while competition remains free. The Germans are able to pursue such a policy to their obvious advantage, because their iron and steel industries are held as it were in one hand through the operation of close syndicates. In America, there is no monopoly and not even an attempt at control.

The question, so often raised, as to how long the present period of great activity and high prices can last will be answered by different authorities very much according to mental habit and temperament. The conservative reasons from past experience that booms are short-lived; that we have usually had five years of declining to two years of advancing prices; that we must before long pay the penalty of the great increase of production witnessed the past three years; that over-capitalization of companies and speculative trading can have but one end, etc. The man of optimistic views sees before us a period of national development, and of material progress throughout the world, compared with which even the great achievements of the past are tame. He reasons that iron and steel lie at the very foundation of such progress, and that it is the destiny of the United States to furnish a steadily increasing proportion of the world's requirements. He thinks the past five years, with its creation of wealth, its payments of debts, its settlement of financial questions, its uplift in the spirit and ambition of the people, has brought in a new era, and that it is narrow and fallacious to try to square the conditions of today with those which prevailed in the years of panic and turmoil. Space is wanting here to analyze these opposing views and try to reach conclusions. But it is worthy of mention that in like discussions and forecasts in the past forty years, no prophet has been bold or visionary enough to predict the results which have really come to pass in the growth of the iron and steel industry of this great country.

# THE PHYSICAL LIMITS OF ELECTRIC-POWER TRANSMISSION.

*By Alton D. Adams.*

ELECTRICAL energy may be transmitted around the world if the line voltage is unlimited. This follows from the law that a given power may be transmitted to any distance with constant efficiency and a fixed weight of conductors, provided the voltage is increased directly with the distance.

The physical limits of electric-power transmission are thus fixed by the practicable voltage that may be employed. The effects of the voltage of transmission must be met in the apparatus at generating and receiving stations, on the one hand, and along the line on the other. In both situations experience is the main guide, and theory has little that is reliable to offer as to the limit beyond which the voltage will prove unworkable.

Electric generators are the points in a transmission system where the limit of practical voltage is first reached. In almost all high-voltage transmissions at the present day alternating generators are employed. Very few continuous-current dynamos with capacities in the hundreds of kilowatts and voltages above 4,000 have been built in Europe, and probably none in the United States. This is due to the troubles encountered at commutators when the effort is made to deliver energy at a greater rate and voltage than that just named. Where a transmission at high voltage is to be accomplished with continuous current, two or more dynamos are usually joined in series at the generating station, and a similar arrangement with motors is made at the receiving station, so that the desired voltage is available at the line though not present at any one machine.

Quite a number of such transmissions have been carried out in Europe with satisfactory results, and in one case a line pressure as high as 14,400 volts is in regular use, this being the voltage employed between Combe-Garat and La Chaux-de-Fonds, in Switzerland. Eight dynamos are connected in series to obtain the voltage named. For a transmission from the falls of Saint Maurice to Lausanne, Switzerland, ten dynamos in series are used, giving a maximum of 22,000 volts. Plants of this sort require very thorough insulation at each dynamo, but this is fairly easy to obtain and there is no indication that the limit of practicable voltage has been reached, since higher voltage can be had by simply connecting more dynamos in series. In a system of this sort the frame of each dynamo is insulated from the earth in a very substantial manner, so as to limit the electric stress on the insulation between the windings and frame of any one dynamo to the voltage developed by it alone. Alternating dynamos that deliver current at about 6,000 volts have been in regular use for several years, in capacities of some hundreds of kilowatts each, and may readily be had of several thousand kilowatts capacity. But even 6,000 volts is not an economical pressure for transmissions over fifteen to fifty miles, such as are now quite common; consequently in such transmissions it has been the rule to employ alternators that operate at less than 3,000 volts, and to raise this voltage to the desired line pressure by step-up transformers at the generating station. More recently, however, the voltage of alternating generators has been pushed as high as 13,000 in the revolving-magnet type where all the armature windings are stationary. This voltage makes it practicable to dispense with the use of step-up transformers for transmissions up to or even beyond thirty miles in some cases. This voltage of 13,000 in the armature coils is attained only by constructions involving some difficulty because of the relatively large amount of room necessary for the insulating materials on coils that develop this pressure. The tendency of this construction is to give alternators unusually large dimensions per given capacity. It is quite clear, moreover, that the pressures developed in the armature coils of alternating generators must reach their higher limits at a point much below the 50,000 and 60,000 volts in actual use on present transmission lines. In the longest transmissions with alternating current there is, therefore, no prospect that step-up transformers at the generating stations and step-down transformers at receiving stations can be dispensed with. The highest voltage that may be received or delivered at these stations is simply the highest that it is practicable to develop by transformers.

A very high degree of insulation is much more easy to attain in transformers than in generator armatures, because the space that can be readily made available for insulating materials is far greater in the transformers, and further because their construction permits the complete immersion of their coils in petroleum. This oil is not only an excellent insulator but offers a much greater resistance than air to the passage of electric sparks, which tend to set up arcs between coils at very high voltages and thus destroy the insulation. Danger to insulation from the effect known as creeping between coils at widely different pressures is largely avoided by immersion of the coils in oil. For several years groups of transformers have been worked regularly at 40,000 volts, notably those concerned in the transmission of power from Provo to the Mercur mills, Utah, over a distance of 35 miles. More recently transformers operating most of the time at 40,000 volts, but on one or two occasions at 60,000 volts for which they are ultimately intended, have been used in the transmission from the Colgate power house in Yuba County, California, to San Francisco, a distance by the line of 218 miles. Since the early months of the present year transformers have been operating at 50,000 volts at Cañon Ferry and Butte, Montana, for the purpose of an electrical transmission between these points, a distance of 70 miles. In none of these instances where transformers are working at 40,000 to 60,000 volts is there any indication that the upper limit of practicable voltage has been reached. On the contrary, transformers have repeatedly been worked experimentally up to and above 100,000 volts.

From all these facts, and others of similar import, it is fair to conclude that the physical limit to the voltages that it is practicable to obtain with transformers is much above the 50,000 or 60,000 volts now in practical use on transmission systems. So far as present practice is concerned, the limit to the use of high voltages must be sought beyond the transformers and outside of generating and receiving stations. As now constructed, the line is that part of the transmission system where a physical limit to the use of higher voltages will first be reached. The factors that tend most directly to this limit are two—temporary arcing between the several wires on a pole, and the less imposing but constant passage of energy from one wire to another. On lines of very high voltage arcing is occasionally set up by one of several causes. At a point where one or more of the insulators on which the wires are mounted become broken or defective, the current is apt to flow from one wire to another along a wet cross arm, until the wood grows carbonized and an arc is formed that ends by burning up the cross arm or even the pole. Where lines are exposed to heavy sea fog, the salt is in some cases depositd on the insulators and cross arms to an extent that starts an arc between the wires, and ends often in the destruction of the cross arm. One part of the 40,000-volt line between Provo and Mercur mills, Utah, runs near a former basin of Great Salt Lake, where the soil has much salt mixed with it. This salt is deposited with dust on the insulators and cross arms supporting the wires, and gives rise to arcs from wire to wire that consume energy at a rapid rate while they last, which is usually not more than a few seconds for a single arc. Occasionally a series of arcs from the cause just named follow each other rapidly and become a very serious matter. The three wires of this line are arranged at the corners of a triangle about six feet apart, and the arcs started by deposits of salt often involve all three wires and flame up above them. Lines not subject to the action of salt fog or dust are much less liable to develop arcs, other conditions being the same. In some instances the glass and porcelain insulators supporting wires used with high voltages are punctured by sparks that pass right through the material of the insulator to the pin on which it is mounted, thus burning the pin and ultimately the cross arm. This trouble is easily met, however, by the adoption of a better grade of porcelain or of an insulator with a greater thickness of glass or porcelain between the wire and the supporting pin. Arcs between lines at high voltages usually start by sparks that jump from the lower edges of insulators, when they are wet or covered with salt deposit, to the cross arm. As the lower edges of insulators are only a few inches from their cross arms, the sparks find a path of comparatively low resistance by passing from insulator to cross arm and thence to the other insulator and wire. The wood of a wet cross arm is a far better conductor than the air. Where wires are several feet or more apart, sparks probably never jump directly through the air from one to the other. Large birds flying close to such wires, however, have in many instances started momentary arcs between them. The treatment of cross arms with oil or paraffine reduces the number of arcs that occur on a line of high voltage, but does not entirely do away with them.

As the voltages of long transmissions have gone up, the distance through the air between wires and the distances between the lower wet edges of insulators and the cross arms have been much increased. Most of the earlier transmission lines for high voltages were erected on insulators spaced from one to two feet apart. In contrast with this practice, the three wires of the transmission line put into operation at 50,000 volts between Cañon Ferry and Butte, a few months since, are arranged at the corners of a triangle 78 inches apart, one wire at the top of each pole and the other two at opposite ends of the cross arm. A voltage that would just start an arc along a wet cross arm between wires 18 inches apart would be quite powerless to do so over 78 inches of cross arm, the lower wet edges of insulators being equidistant from cross arms in the two cases. To reach the cross arm, the electric current passes down over the wet or dirty outside surface of the insulator to its lower edge. In the older types of insulators the lower wet edge often came within two inches of the cross arm. For the 50,000-volt line just mentioned the insulators are mounted with their lower wet edges about eight inches above the cross arms. At its lower edge each insulator has a diameter of nine inches, and a small glass sleeve extends several inches below this edge and close to the wooden pin, to prevent sparking from the lower wet edge of the insulator to the pin. These increased distances between wires in a direct line through the air, and also the greater distances between the lower wet edges of insulators and their pins and cross arms, are proving fairly effective to prevent serious arcing under good climatic conditions, for the maximum pressures of 50,000 to 60,000 volts now in use. If these voltages are to be greatly exceeded it is practically certain that the distance between wires, and from the lower wet edges of insulators to the wood of poles or cross arms, must be still further increased to avoid destructive arcing.

The nearest approach to an absolute physical limit of voltage with present line construction is met in the constant passage of energy through the air from wire to wire of a circuit. A paper by Mr. Scott, Vol. XV, T. A. I. E. E., gives the tests made at Telluride, Colorado, to determine the rates at which energy is lost by passing through the air from one wire to another of the same circuit. The tests at Telluride were made with two-wire circuits strung on a pole line 11,720 feet in length. Measurements were made of the energy escaping from wire to wire at different voltages on the line, and also with the two wires at various distances apart. It was found that the loss of energy over the surfaces of insulators was very slight, and that the loss incident to the passage of energy directly through the air is the main one to be considered. This leakage through the air varies with the length of the line, as might be expected. Tests were made with pairs of wires running the entire length of the pole line and at distances of 15, 22, 35, and 52 inches apart respectively. Losses with wires 22 or 35 inches apart were intermediate to the losses when wires were 15 and 52 inches apart respectively. Results given in the original paper for the pair of wires that were 15 inches apart and for the pair that were 52 inches apart, are here reduced to approximate watts per mile of two-wire line. At 40,000 volts the loss between the two wires that were 15 inches apart was about 150 watts per mile, and between the two wires that were 52 inches apart the loss was 84 watts per mile. The two wires 15 inches apart showed a leakage of approximately 413 watts per mile when the voltage was up to 44,000 volts, but the wires 52 inches apart were subject to a leakage of only 94 watts per mile at the same voltage. At 47,300 volts, the highest pressure recorded for the two wires 15 inches apart, the leakage between them was about 1,215 watts per mile, while an equal voltage on the two wires 52 inches apart caused a leakage of only 122 watts per mile or one-tenth of that between the wires that were 15 inches apart. When about 50,000 volts was reached on the two wires 52 inches apart, the leakage between them amounted to 140 watts per mile, but beyond this voltage the loss went up rapidly, and was 225 watts per mile at about 54,600 volts. For higher pressures the loss between these two wires was still more rapidly increased, and amounted to 1,368 watts per mile with about 59,300 volts, the highest number recorded. With a loss of about 1,215 watts per mile between the two wires 52 inches apart, the voltage on them was 58,800, in contrast with the 47,300 volts producing the same leakage on the two wires 15 inches apart.

Evidently, however, at even 52 inches between line wires the limit of high voltage is not far away. When the voltage on the 52-inch line was raised from 54,600 to 59,300, the leakage loss between the two wires increased about 1,143 watts per mile. If the leakage increases at least in like proportion, as seems probable, for still higher pressures, the loss between the two wires would amount to 6,321 watts per mile with 80,000 volts on the line. On a line 200 miles long this loss by leakage between the two wires would amount to 1,264,200 watts. Any such leakage as this obviously sets an absolute, physical limit to the voltage, and consequently the length, of transmission.

Fortunately for the future delivery of energy to great distances from its source, the means to avoid the limit just discussed, though novel, are not difficult. The electrical resistance of air, like that of any other substance, increases with the length of the circuit through it. The leakage described is a flow of electrical energy through the air from one wire to another of the same circuit. To reduce this leakage it is simply necessary to give the path from wire to wire through the air greater electrical resistance by increasing its length, that is, by placing the wires at greater distances apart. The fact demonstrated at Telluride, that with 47,300 volts on each line the leakage per mile between the two wires 15 inches apart was ten times as great as the leakage between the two wires 52 inches apart, is full of meaning. Evidently, leakage through the air may be reduced to any desired extent by suitable increase of distance between the wires of the same circuit. But to carry this increase of distance between wires very far involves radical changes in line construction. Thus far it has been the uniform practice to carry the two or three wires of a transmission circuit on a single line of poles, and in many cases several such circuits are mounted on the same pole line. For the 70-mile transmission into Butte, Montana, only the three wires of a single circuit are mounted on one pole line, and this represents the best present practice. The cross arms on this line are each 8 feet long, and one is attached to each pole. The poles are not less than 35 feet long and have 8-inch tops. One wire is mounted at the top of each pole, and the other two wires near the ends of the cross arm, so that the three wires are equidistant and 78 inches apart. By the use of still heavier poles the length of cross arms may be increased to 12 or 14 feet, for which their section should be not less than 4 by 6 inches. Placing one wire at the pole top, the 12-foot cross arm would permit the three wires of a circuit to be spaced about 10.5 feet apart. The cost of extra large poles goes up rapidly and there are alternative constructions that seem better suited to the case. Moreover, a few tens of thousands of volts above present practice would bring us again to a point where even 10.5 feet between wires would not prevent a prohibitive leakage. Two poles might be set 20 feet apart, with a cross piece between them, extending out 5 feet beyond each pole and having a total length of 30 feet. This would permit three wires to be mounted along the cross piece at points about 14 feet apart. Such a cross piece would approach a pole of moderate size in cost, and the distance between wires would soon reach its limit. Moreover, the support of wires carrying extremely high voltages above any horizontal arm is objectionable, because the lower wet edge of each insulator cannot be very far from such an arm, no matter how great the diameter of the insulator.

If the present transmission pressures of 50,000 to 60,000 volts are to be greatly exceeded, the best line structure seems to involve the use of a separate pole for each wire of a circuit, each wire to be mounted at the top of its pole. This construction calls for three lines of poles to carry the three wires of a three-phase transmission. Each of these poles may be of only moderate dimensions, say 30 feet long with 6- or 7-inch top. The cost of three of these poles will exceed by only a moderate percentage that of a 35- or 40-foot pole with an 8- to 10-inch top, such as would be necessary with 12-foot cross arms. The distance between these poles at right angles to the line may be anything desired, so that leakage from wire to wire through the air will be reduced to a trifling matter at any voltage. Extra long pins and insulators of the umbrella type at the pole tops will easily give a distance of two feet or more between the lower wet edge of each insulator and the wood of pin or pole. Such line construction would probably safely carry two or three times the maximum voltage of present practice, and would force the physical limit of electrical transmission back to the highest pressure at which transformers could be operated.

# SALIENT FEATURES OF THE DÜSSELDORF EXPOSITION.

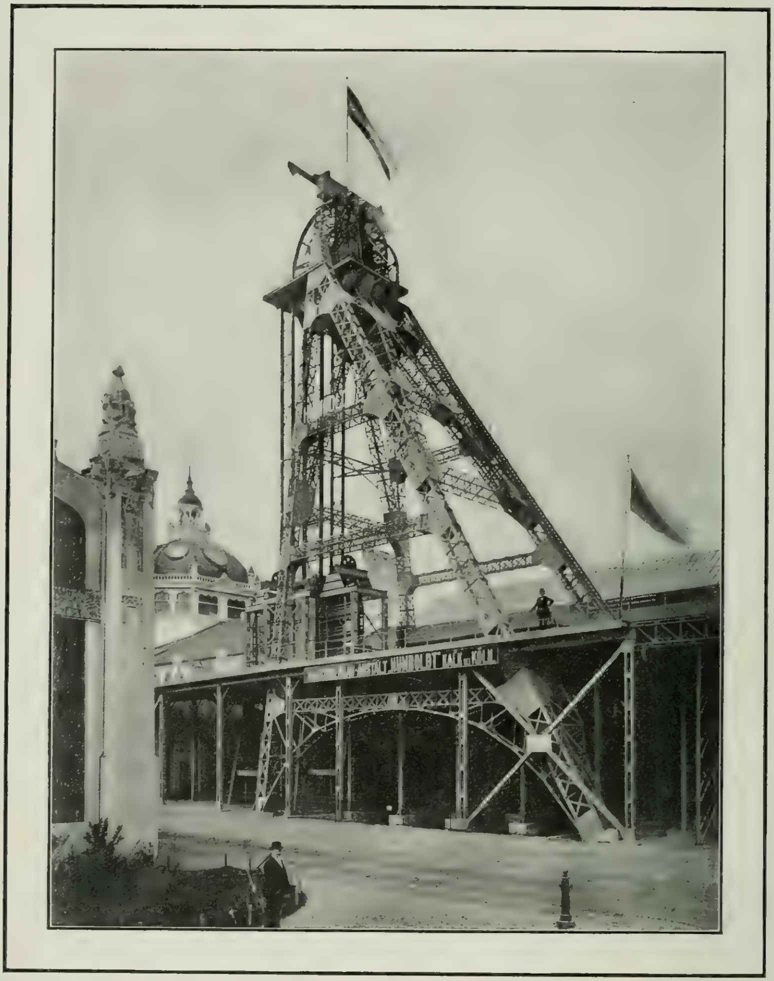
*By Harrington Emerson.*

The Düsseldorf Exposition has not attracted the attention it merits from English-speaking countries—partly, no doubt, through England's engrossment in the war and, later, in the coronation, and the United States' absorption in extraordinarily active home trade. This short review touches only the salient features of an exhibition which was highly illustrative of, and highly creditable to, the engineering industries and especially the iron and steel trade of Germany.—The Editors.

DÜSSELDORF, on the right bank of the Rhine, a few miles below the more saintly Cologne, was at least a village nine hundred years ago and remained until this century little more than a pious residential village for countless princelings. It was furiously bombarded by the French in 1794, later became the capital of one of the Napoleonic duchies, succeeded to the benefits of the Code Napoleon, was given the rights of a free port in 1829, and even before that time became central and port city for the great coal and iron province of the German Empire, Rhenish Prussia, which is, on a very condensed scale, the Pittsburg-Buffalo-Cleveland region of Germany.

What iron and coal does for a region in concentration of population is shown here by a density of 500 inhabitants per square mile. This is one of the most densely populated regions of Europe, if cities alone are not counted. The neighboring fens of Hannover have a population of less than 40 to the mile. The dense population within a radius of ten miles is partly concentrated in four large cities—Düsseldorf, the port on the Rhine, a city with a history, with art galleries, and with a great polytechnic school; Barmen and Elberfeld, only five miles apart; and the city of Essen, which could more properly be called Kruppville, as the great Krupp establishment has on its payroll 43,000, of whom 25,000 are in Essen alone out of a total population of 117,000 in 1899. The history of the Krupps is an epitome of the growth of the whole province, and the firm's display is the most important part of the Düsseldorf exposition.

Just a generation ago, in 1880, Düsseldorf had a successful exposition, and the younger generation was desirous for another to show the city's advance. Then, too, there was disappointment over the



MINE HEADWORKS, ERECTED BY THE MASCHINENBAU ANSTALT HUMBOLT, KALK BEI KÖLN.

small space allotted to the iron industries of Rhenish Prussia and Westphalia at the Paris Exposition of 1900. The whole of Germany had none too large a space, and this was apportioned among the various parts of the empire.

Only recently Düsseldorf had won in a great struggle with the Rhine which was depositing on the inside of the bend opposite the city and encroaching on the outside of the water curve where Düsseldorf stands. This struggle had been going on for centuries, the Rhine having swallowed everything except the mediæval Thomas bastion, and lower down the castle of the Dukes of Berg. The building of a harbor, finished in 1896, and the erection of the great Rhine bridge, begun the same year, gave an opportunity finally to conquer the river at a cost of over a million marks.

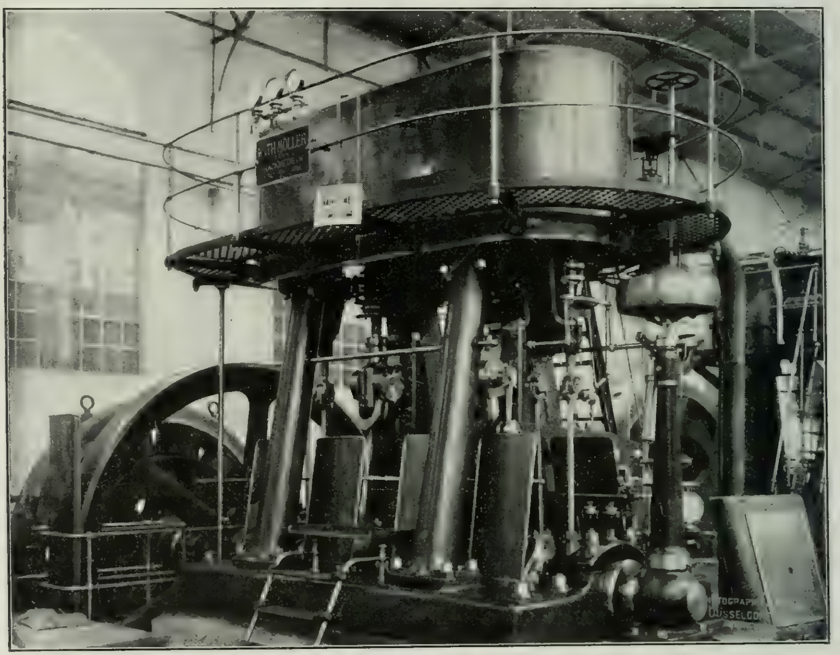
The right bank was filled in, and this inundated portion of the city and the swamp and meadow lands of the island Galzheim, in all a tract a mile and a quarter long, 800 feet wide, rising in terraces, was offered by the city for the exposition. To avoid the contingency of a June overflow, most of the buildings were placed thirty feet above low-water mark, the art gallery and machinery hall being thirty-five feet above. As the fine arts building was to be of stone and permanent, it became doubly necessary to place it on the highest ground. And alongside of it is the machine hall containing also enormously valuable exhibits impossible to move quickly.

THE GUTEHOFFNUNGSHÜTTE COMPANY'S BUILDING AT DÜSSELDORF.
*By courtesy of the Scientific American.*

After it was resolved to hold an exposition, the large manufacturers took the lead, and it is typical of the slow changes in Germany that, instead of a young man, Mr. Ling, who had successfully directed the former exposition, was again placed in charge. The committee on plans met in July, 1900, and accepted the designs of the Hamburg architect, George Thielen, who did not live to see his work completed.

Under these plans, however, the cost of the main building was to reach 1,800,000 marks, but the frugal estimates had only provided for 900,000. By dint of rigid economies, suppressions, and curtailments, the lesser sum was made to do.

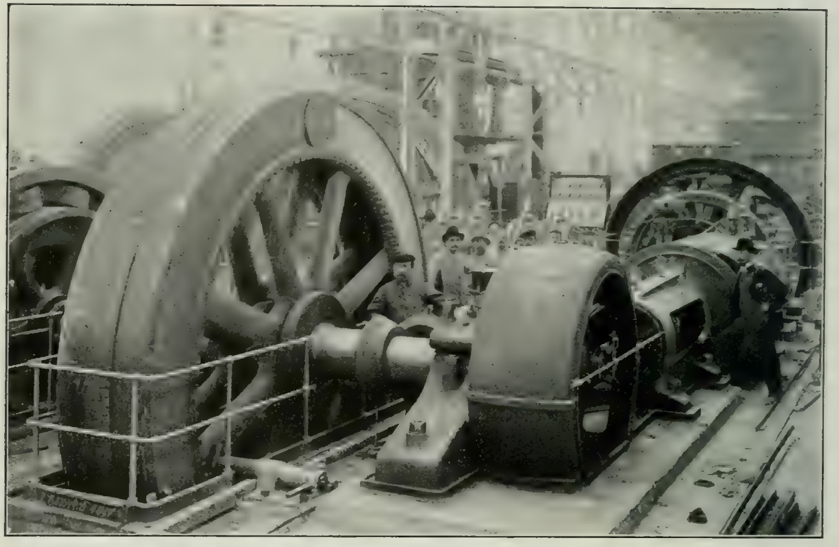
In two respects the Düsseldorf exposition has surpassed all its predecessors. It was ready on time, largely because the chief exhibitors were big firms who did not wait until the last minute, and it has been managed with extraordinary economy and financial ability. A sum of 520,000 marks was secured by private subscription, of which 300,000 marks only was donated. The Düsseldorf citizens subscribed to a guarantee fund of 3,000,000 marks, the Rhenish Westphalia Coal Syndicate gave 100,000 marks, and the provincial governments of Rhenish Prussia and Westphalia guaranteed respectively 1,000,000 marks and 600,000 marks, of which nine-tenths was to be returned.



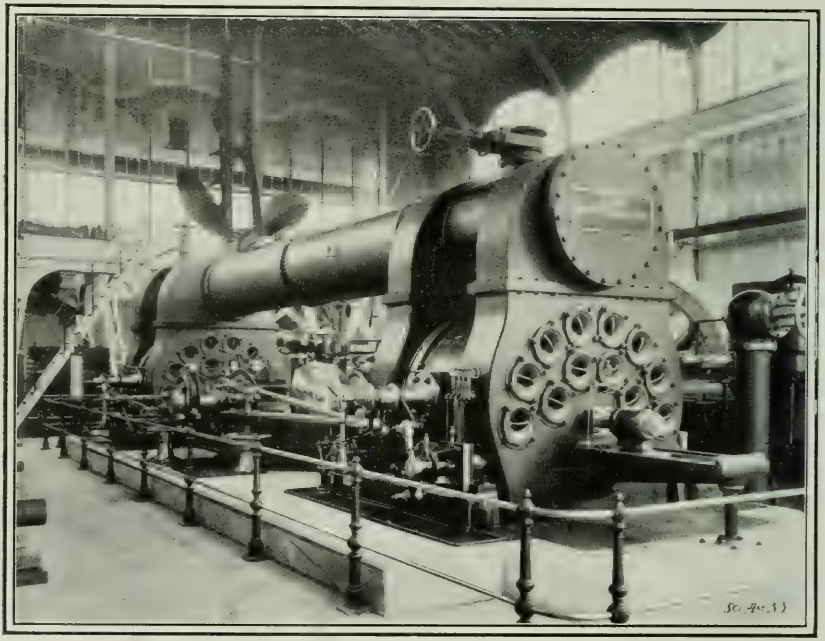
VERTICAL COMPOUND ENGINE BUILT BY K. & TH. MÖLLER, BRACKWEDE I. W.
330 horse-power, 120 revolutions.

In general, the fiscal plan was to start with a small donation, to supplement this with what were in fact, if not in name, debenture loans, but in the main to expect the exposition to be self-supporting. The budget as finally arranged in 1900 was as follows, all sums being expressed in marks:

| | Divisions | Receipts. | Expenses. |
|---|---|---|---|
| 1 | Subscriptions | 608,450 | 124,000 |
| 2 | Guarantees | 147,550 | 170,000 |
| 3 | Main Building | ——— | 1,000,000 |
| 4 | Machinery Hall | ——— | 600,000 |
| 5 | Fine Arts | 345,000 | 1,045,000 |
| 6 | Horticultural Hall | ——— | 50,000 |
| 7 | Parking and Flower Beds | ——— | 80,000 |
| 8 | Paths and Terraces | ——— | 92,000 |
| 9 | Rail Road | 70,000 | 100,000 |
| 10 | Restaurant Buildings | 100,000 | 200,000 |
| 11 | Water and Gas | 3,000 | 100,000 |
| 12 | Steam Boilers | ——— | 50,000 |
| 13 | Enclosures | 15,000 | 35,000 |
| 14 | Water Courses | ——— | 30,000 |
| 15 | Music Pavillions | ——— | 12,000 |
| 16 | Fences, etc. | ——— | 85,000 |
| 17 | Preparation of Site | ——— | 10,000 |
| 18 | Administration Buildings | ——— | 20,000 |
| 19 | Interior Decoration | 5,000 | 80,000 |
| 20 | Flags and External Decorations | ——— | 50,000 |
| 21 | Insurance Premiums | 80,000 | 100,000 |
| 22 | Space for Exhibitors | 860,000 | ——— |
| 23 | Restaurant Privileges | 150,000 | ——— |
| 24 | Wine and Lunch Counters | 450,000 | ——— |
| 25 | Commissions on Sales | 50,000 | ——— |
| 26 | Lottery | 1,200,000 | 900,000 |
| 27 | Entrance Receipts | 2,300,000 | 5,000 |
| 28 | Catalogs and Guides | 75,000 | 30,000 |
| 29 | Advertising | ——— | 200,000 |
| 30 | Exposition Newspapers, to opening | 40,000 | 45,000 |
| 31 | Exposition Newspapers During Exposition | 40,000 | ——— |
| 32 | Medals and Diplomas | ——— | 25,000 |
| 33 | Music, Fireworks, Sports | ——— | 200,000 |
| 34 | Electric Light and Power | 150,000 | 350,000 |
| 35 | Water and Gas Supply | 5,000 | 50,000 |
| 36 | Competition Plans | ——— | 30,000 |
| 37 | Committee on Care of Visitors | 1,000 | 5,000 |
| 38 | Prizes for Various Societies | ——— | 5,000 |
| 39 | Office and Entertainments | ——— | 300,000 |
| 40 | Postage | ——— | 15,000 |
| 41 | Rent of Offices | ——— | 3,500 |
| 42 | Inventory | 5,000 | 30,000 |
| 43 | Salaries and Uniforms of Attendants | ——— | 100,000 |
| 44 | Firemen, Police, Hygiene | ——— | 60,000 |
| 45 | Salaries of Administration | ——— | 70,000 |
| 46 | Agencies | ——— | 20,000 |
| 47 | Interest on Borrowed Money | ——— | 75,000 |
| 48 | Contingent Fund | ——— | 148,500 |
| | | 6,700,000 | 6,700,000 |



"UNION" TANDEM-COMPOUND ENGINE AND LAHMEYER DYNAMO.
500 horse-power, 94 revolutions.



GUTEHOFFNUNGSHÜTTE COMPANY'S EXHIBIT—1,000-HORSE-POWER BLAST-FURNACE-GAS ENGINE.
*By courtesy of the Scientific American.*

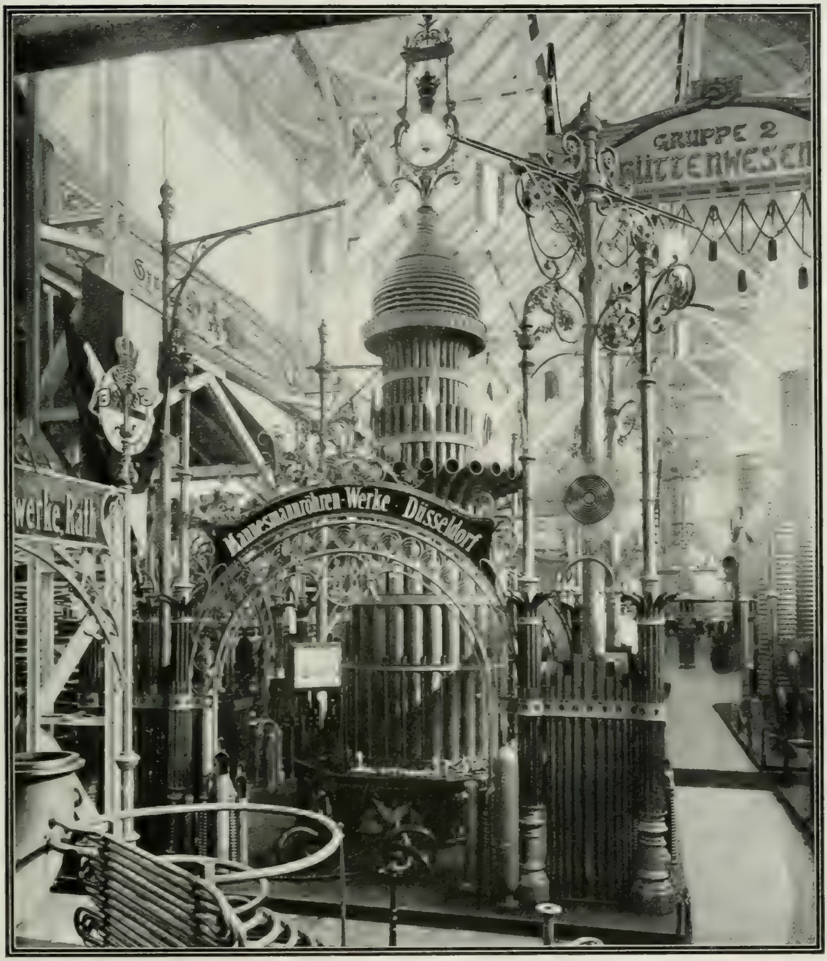


EXHIBIT OF THE MANNESMAN TUBE WORKS, DÜSSELDORF.

The total extent of the exposition grounds is 5,830,000 square feet, or about 140 acres, the portion, covered with buildings being about 40 acres. The buildings cover more space than those of the Paris exposition of 1867, and very nearly as much as the Vienna exposition of 1873—two to four times as much space as the previous German expositions of Nürnberg, Leipzig, and Berlin. The figures of these comparisons are furnished in the official guide, which ignores the Columbian exposition in Chicago in 1893, as well as the lesser undertakings at Omaha, Buffalo, and Charleston. Düsseldorf gives some interesting figures showing the relative importance of human affairs:—

| | | |
|---|---|---|
| Main Industrial Hall | 318,000 | square feet |
| Machinery Hall | 156,000 | " " |
| Gallery of Fine Arts | 86,000 | " " |
| Restaurant | 30,200 | " " |
| Wine Room | 20,500 | " " |
| Power House | 15,000 | " " |

The committee in charge did not see its way clear to take the risk of removing the machinery hall, built of iron, after the exposition was over; so they arranged to borrow the building for a fixed payment from the firm building it, and this firm, in order to lose as little as possible, put up the building with reference to its ultimate removal and salvage. Its situation and its width were determined by the condition of the ground. It must be above high-water mark; it could not be very wide, so it had to make up in length for the curtailment in width. The result is a long hall in three sections, of which the central and main hall is 80 feet wide and 920 feet long, the two wings being each 45 feet wide. The central hall is provided with three electric travelling cranes, each of 30-tons capacity, and a running height of 35 feet. Each of the wings has four electric cranes of 10- to 15-tons capacity and a height of 22 feet. That the eleven travelling cranes are all electric indicates to what extent, in this line at least, electricity has won in the race with steam.

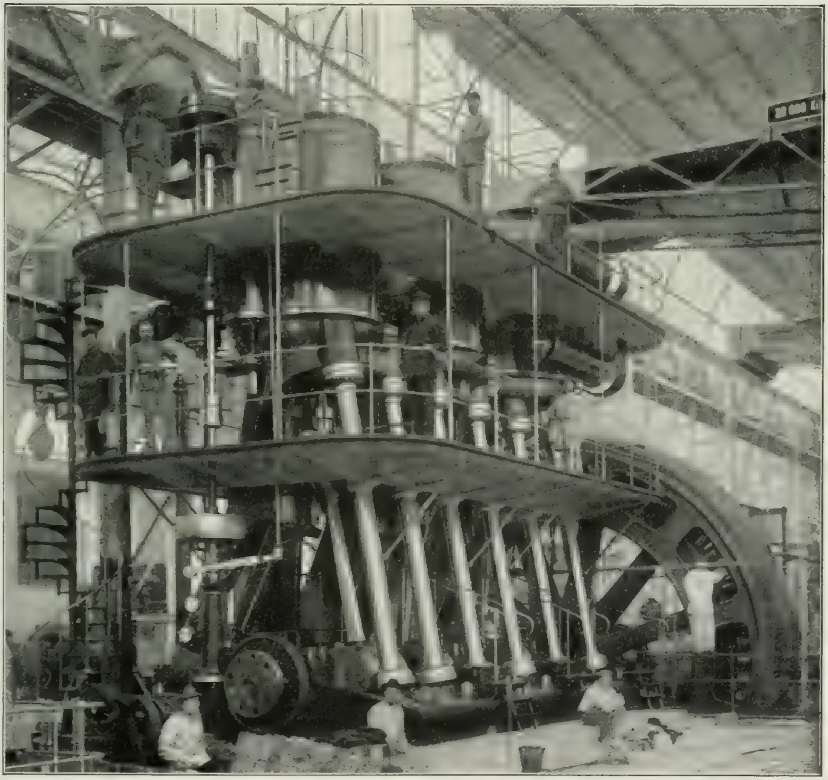
For purposes of illumination electricity shows no such victory. At Buffalo there was only electricity and acetylene, but at Düsseldorf there are electric lights, alcohol incandescent lights, city gas, compressed gas, and incandescent kerosene lights of the Washington patents. Nevertheless electric lights exceed all others, numbering 4,000 incandescents and 1,000 arc lights. 12,000 electric horse power is generated on the grounds, of which one-half is for supply of power and the other half for lights. The prime movers are twenty-six steam engines with twenty-seven, nearly all direct-coupled dynamos. For direct current both 115 and 220 volts are used, but nothing higher. In the triphase, currents of 2,000 and 5,000 volts are employed and alternating currents of 10,000 volts.

Water is drawn mainly from the Rhine by four electrically driven centrifugal pumps with a combined capacity of 18,500 gallons a minute and an average elevation of 25 feet. The electric motors are variable in speed in order to be adjusted to the rise and fall of the river. There are also at the Rhine station two high-pressure centrifugal pumps with a capacity of 1,320 gallons a minute.

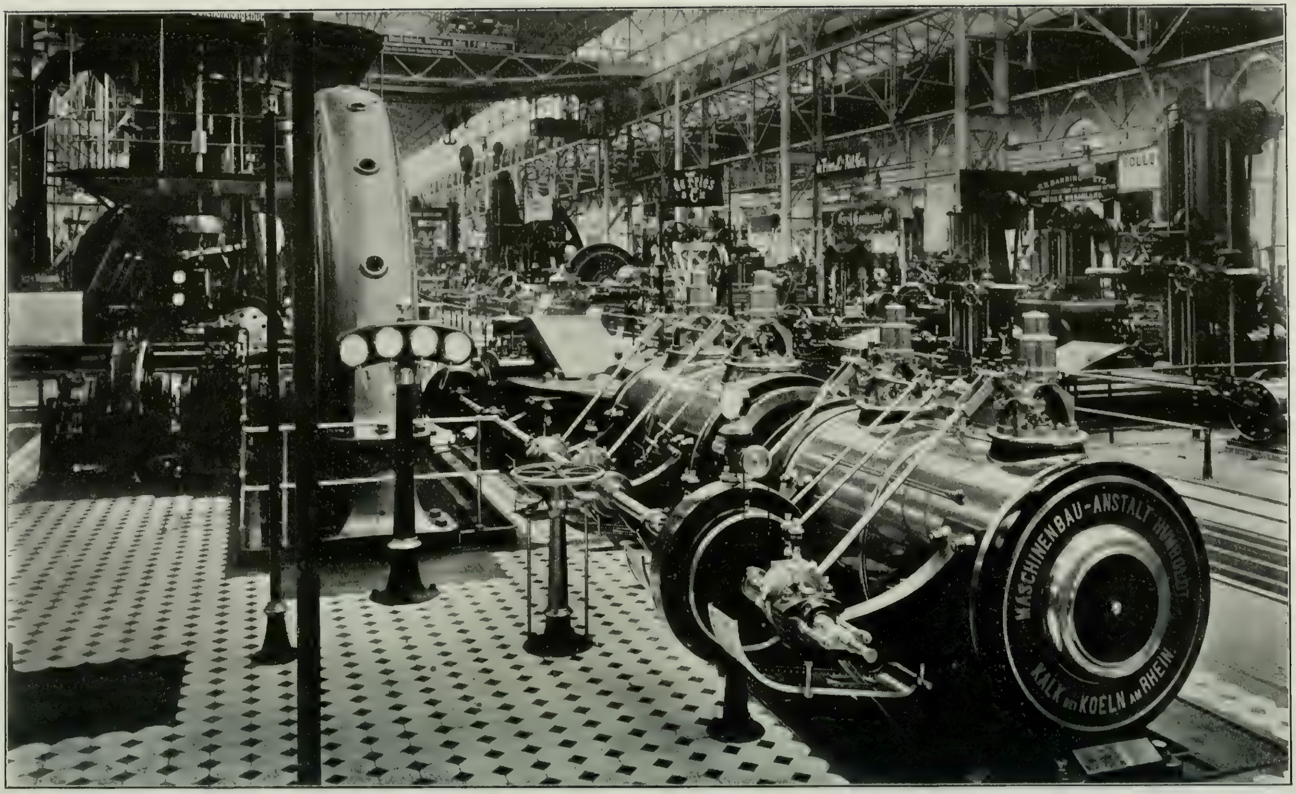
Electricity is generated by four tandem horizontal engines developing altogether 5,000 horse power, four compound horizontal engines giving a total of 1,700 horse power, one three-cylinder vertical engine of 2,750 horse power, seven compound two-cylinder vertical engines, totalling 2,550 horse power, four horizontal one-cylinder engines with a combined output of 220 horse power, one De Laval steam turbine of 100 horse power, and two gas engines, one of 250 and the other of 50 horse power, yielding a total of 12,620 horse power.

There are two power stations, one for bituminous coal and the other for the brown or lignite coal. In the former are sixteen boilers, in the latter three. Gas engines, large and numerous, are installed for power purposes but cut a very insignificant figure in the generation of electricity.

A little railroad run with storage batteries curves through the grounds. Its length is 1.3 miles, the fare 20 pfennigs, the speed a little more than seven miles an hour. To meet the requirements of varying passenger demands the cars run on 5-minute headway with-

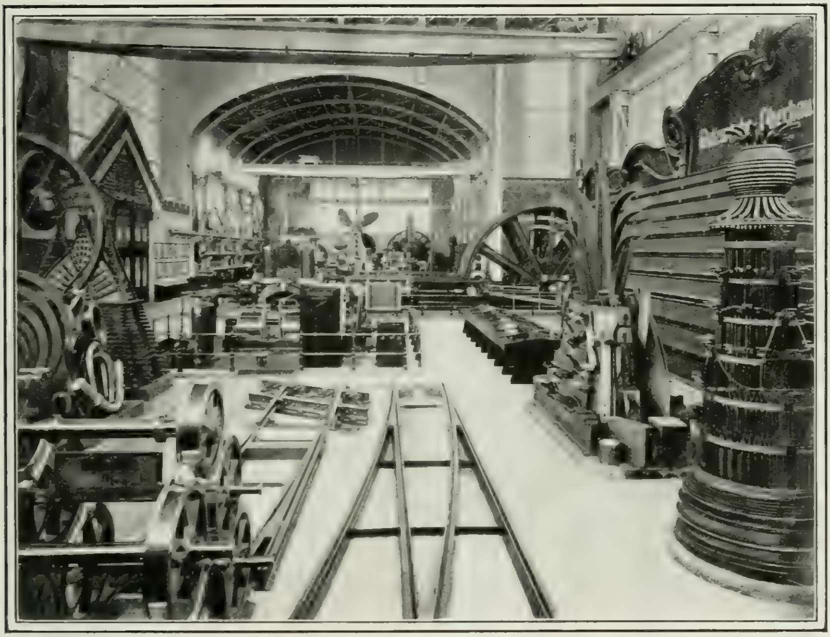


VERTICAL TRIPLE-EXPANSION ENGINE AND DYNAMO, GUTEHOFFNUNGSHÜTTE.
The largest engine in the Exposition, 3,500 horse-power, 94 revolutions.



THE MACHINERY BUILDING. HORIZONTAL TANDEM-COMPOUND ENGINE WITH DYNAMO, HUMBOLDT WORKS, IN THE FOREGROUND.
400 horse-power, 94 revolutions.

out trailer from 10 until 2 o'clock, from 2 until 5 on 2½-minute headway, from 5 to 8 P. M. with trailer on 2½-minute headway, and from 8 to 10 on a 5-minute headway without trailer. The motor car carries forty passengers, the trailer thirty, and tickets are secured from slot machines, an arrangement that might with convenience to the public be introduced on the elevated lines in America.



PART OF EXHIBIT OF THE GUTEHOFFNUNGSHÜTTE COMPANY, OF OBERHAUSEN.
Double tandem hauling engines and Riedler high-voltage 450-horse-power electric-driven pump.
*By courtesy of the Scientific American.*

Only in the most general way can a review be made of some of the exhibits.

Krupp's pavilion covers 45,210 square feet and his prize exhibit is the hollow crucible crank shaft forged from an ingot 12 feet 9½ inches long, 6 feet in diameter, and weighing 80 tons, cast from 1,768 crucibles by 490 men in 30 minutes, forged under a 5,000-ton press in 62 hours, with 22 heats, to a length of 135 feet. The lathe on which it was turned and bored was, length of bed 166 feet 4 inches; useful length, 152 feet 6 inches; swing, 31.5 inches.

In 1840 a forging of 800 pounds was large; in 1851 Krupp exhibited a block of 4,000 pounds; in 1855, 6,000 pounds; in 1861, 50,000 pounds; in Paris in 1867, 80,000 pounds, and in 1887, 170,000 pounds. The present maximum for crucible steel is 85,000 kilos, but the forge is able to handle single pieces weighing 120,000 kilos.

More important than big lathes, big forging, and big castings, are the exhibits of modern rapid-cutting steels, originally developed by Taylor and White at the Bethlehem Iron Works and since put on the market by many steel manufacturers. Krupp shows tools which cut 150 feet a minute (on cast iron 120 feet) and take off 194 kilos an hour. These Krupp tools run several hours without grinding, sometimes days or even weeks, and with a sufficiently strong lathe increase the output four to six times.

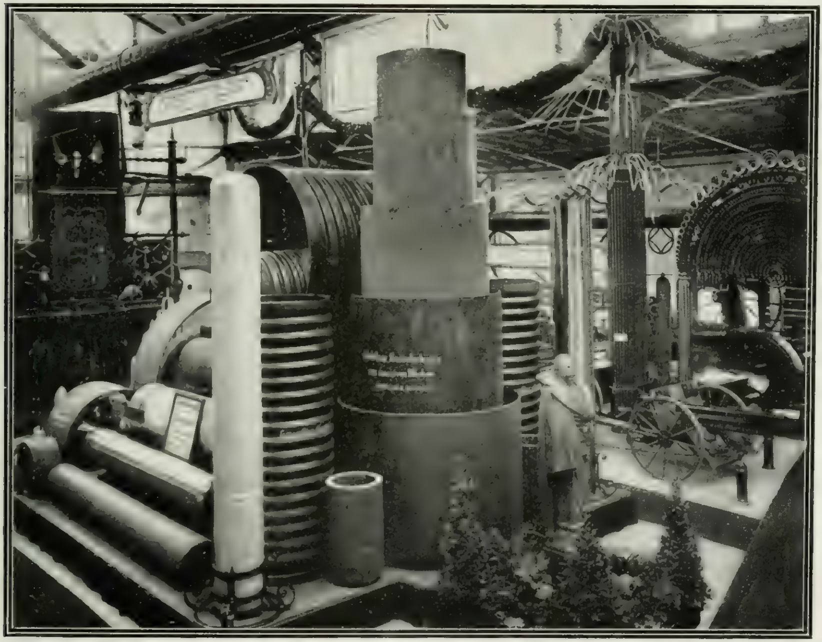
DISPLAY OF THE HORDE BERGWERKS & HÜTTENVEREIN.
Boiler plate 22.5 metres by 3.2 metres suspended on the left.

Another very interesting exhibit of Krupp's are the rock drills, some of them 20 feet long and of great weight, 4 inches square in cross section. They are forged from Martin steel, with an inserted and welded-in wedge of hard crucible steel. Some of these rock cutters have struck 250,000 blows. One of them broke down 35,000 cubic yards of hard slate with 165,000 blows. Krupp also exhibits a torpedo air reservoir 18 inches in diameter, 28/100 inch in thickness which only yielded, splitting open, under a hydraulic pressure of 3,800 pounds per square inch.

There are also designs of small marine engines, 170-horse-power triple-expansion, 10-inch stroke, of which the total weight, including boiler-room equipment, propeller, and connections complete, is 60 pounds per indicated horse power, or, forcing them to 210 horse power, the weight is 50 pounds per indicated horse power.

The Riedler fast pumps at 300 revolutions per minute, pump 8.2 cubic feet of water per minute to a height of 1,968 feet. The electric motor, 200 revolutions per minute, is driven by 450-horse-power triphase 2,000-volt current.

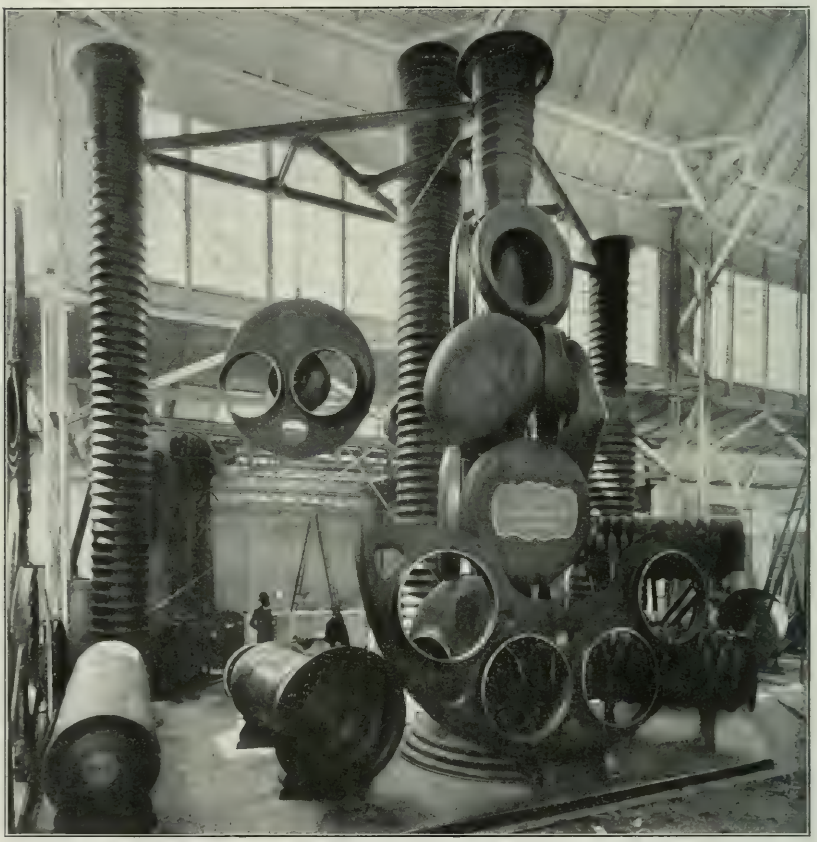
Notable improvements are also shown in hydraulic cements. The so-called iron Portland cement sets very fast and at constant volume. It is made by adding, in exact proportions, finely ground, granulated blast-furnace slag to clinkered Portland cement. So important are exact proportions that to avoid human error, all weighing and mixing are done automatically.



DISPLAY OF THE RHEINISCHE METALLWAAREN FABRIK.

The Düsseldorf exposition is probably the largest and most complete exhibition the world has seen of everything appertaining to heat engines and steel-working machinery, beginning with the mining of lignites and coal, their use under boilers and in gas producers, steam engines both of the reciprocating and turbine type, hydro-carbon engines of all kinds, from the rich kerosene to the lean blast gas, these last giants in size. The power generated is transformed into electricity by direct, alternating, and triphase currents, which in turn drive high-speed reciprocating or centrifugal pumps, move heavy cranes, turn lathes and other machine tools, make incandescent and arc lights and charge batteries for the Exposition railway.

Iron and steel are on hand, from the sections of ore and rock to the highest samples of piano wire, torpedo-reservoir sheets, self-hardening tools which cut when red-hot, iron and steel made by almost every known process—cast, puddled, crucible, Bessemer, Martin, acid and basic processes; steel cast, forged, welded, drawn hot and cold; steels that do not corrode in sea water, or that do not crystalize or do not expand with temperature variations; steel made into needles and almost microscopic screws and watch-springs; ingots of crucible steel



PRODUCTS OF THE PLATE MILLS OF SCHULZ KNAUDT ACTIEN GESELLSCHAFT, ESSEN-RUHR.

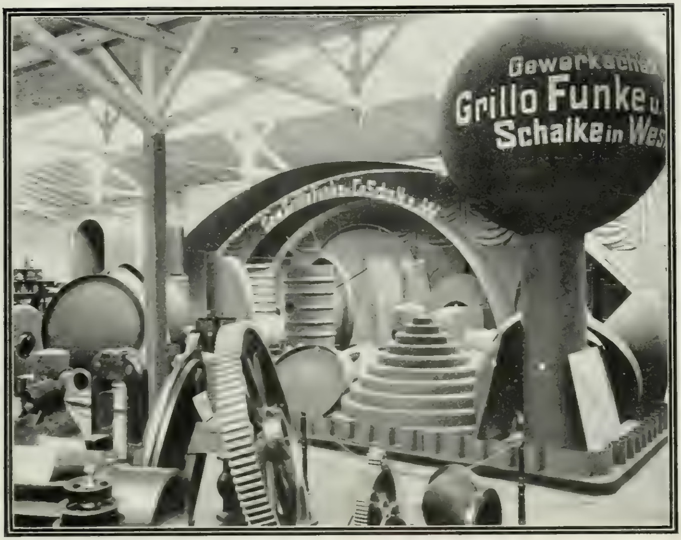
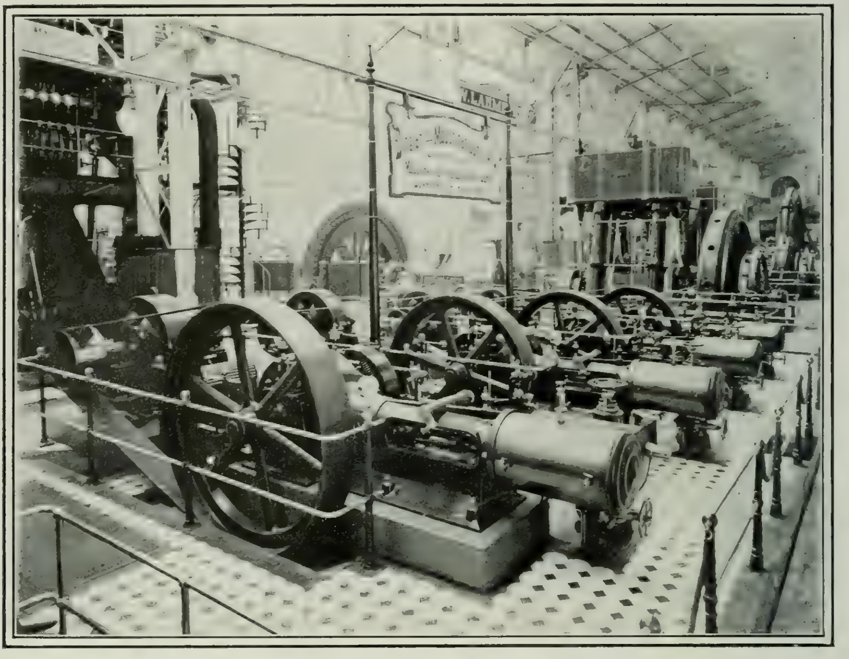


EXHIBIT OF THE GEWERKSCHAFT GRILLO FUNKE & CO., SCHALKE.

weighing 80 tons, forged into shafts 135 feet long, the shafts turned and bored on monster lathes. To the layman steel is steel, but these steels are as specialized as the trotting horse or the German university professor—pre-eminently, superlatively good for one thing.

In comparison with the iron, steel, power and machine exhibits, the great chemical and technical display pales, and the assembled art treasures of modern Germany become an anachronism. The art of the future is as distant from the art of the past as the iron and steel of Cortes and Pizarro are different from the engines of the Inchkeith or of the Deutschland. Bathing nymphs, fighting centaurs, fossilized landscapes, idealized portraits, no longer hold our attention. The moving pictures, the delicately tinted Japanese slides, the marvellous portrait photographs, all stimulate and inspire where the modern gallery depresses. The artist who spends weeks on a single production finds his reward in the work. He sees the soul of things, even though he fail to interpret satisfactorily for others. The engineer who listens to the hum of the 24,000 revolutions per minute of the steam turbine, who photographs the insect or bullet in flight, who measures the radiations from radium, will be satisfied with no less than pictures of the soul itself.

As a whole, the Düsseldorf exposition is unquestionably great. Yet with admiration for the varied and splendid productions, there is disappointment that to only a limited degree have possibilities been



INTERIOR OF MACHINERY HALL AT DÜSSELDORF.
*By courtesy of the Scientific American.*

realized. What of the humanity back of all this effort? Do men exist for the sake of steel? All the influence of Krupp, for example, and all his intelligence, might have been directed *against* the utterly wasted and unproductive implements and paraphernalia of war—might have gone instead into productive German machines.

Stores of the two elements, carbon and iron, deep in the earth, have made Düsseldorf the center of one of the greatest industrial regions in the world. With 8 pounds of steam per horse power hour the steam engine has almost reached the pole of its endeavor; 90-per cent. efficiency in water wheels and dynamos, steel of 200,000-pounds tensile strength—in these directions there is little more to be done; but the average efficiency of man is as yet scarcely one per cent. Many men are many times more efficient than the average; yet who can deny that with wider opportunity or more wisely directed efforts they could not have done tenfold more? Beyond prophets' dreams that nation will surpass its competitors that first learns to make its humblest workman the master, not the slave of his task, thus increasing his potential efficiency to a marked degree.

# ORDNANCE ENGINEERING AS A MECHANICAL INDUSTRY.

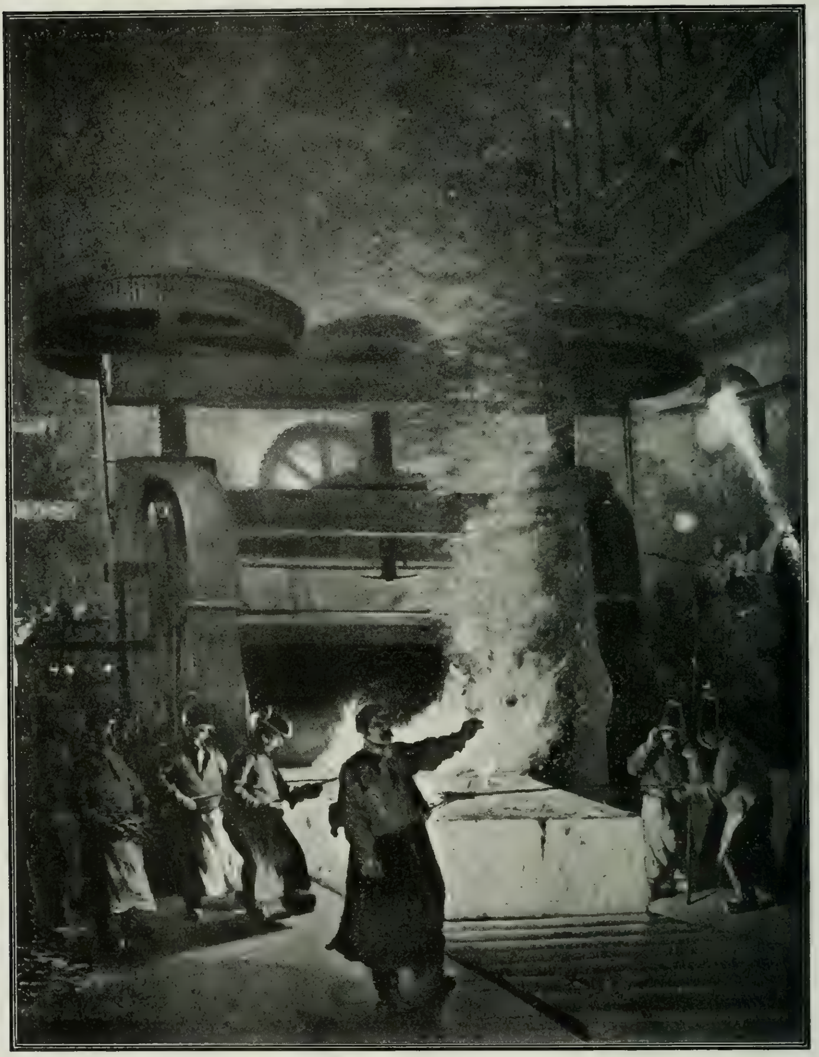
*By J. F. Meigs.*

The mechanics of ordnance engineering have two phases of great interest—first, the wonderful ingenuity developed both in the design of the gun and its mountings and in the processes of manufacture; second, the dynamics of the gun itself regarded as a huge engine for directing and controlling immense forces. It is rather with this second aspect that Mr. Meigs deals.—The Editors.

The Muzzle of the 16-inch Gun.

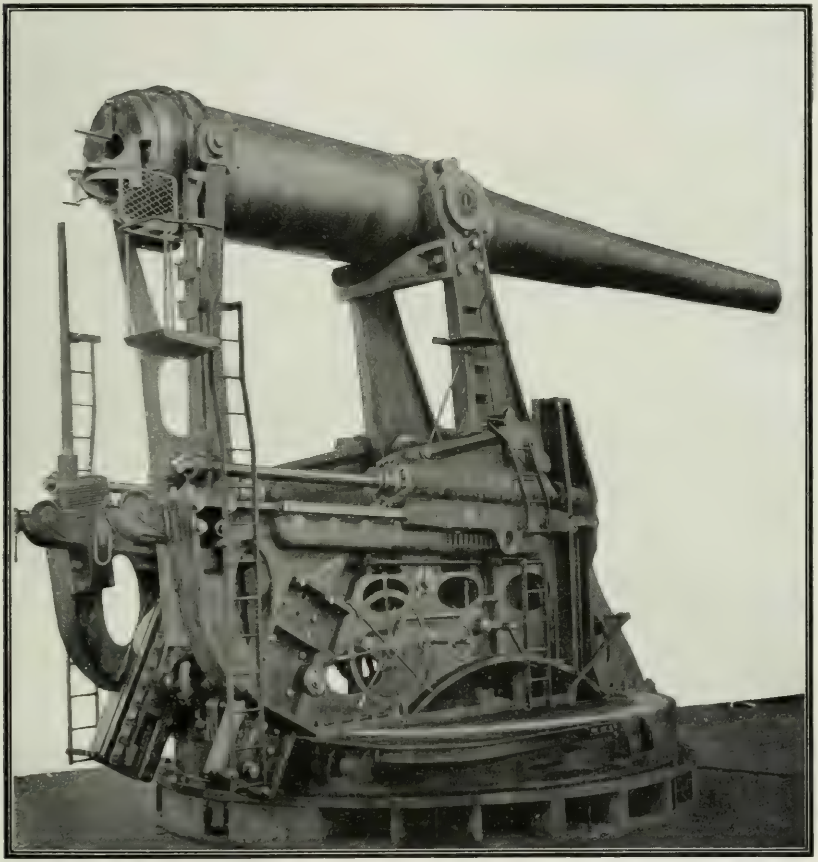
RDNANCE engineering is concerned with the design and construction of the implements of the attack and defense of nations. At the present time there are in the world more than one hundred armored battle-ships under construction, and the coasts and land frontiers of countries are being defended with elaborate systems of fortifications and guns. These defensive arrangements have greatly increased in modern times, and it is now recognized that they are necessary to national safety. The guns in the above classification include only what are called "guns of position," and besides these, all of the Great Powers have stationary and movable torpedoes, field, siege, and mountain artillery, and, descending again in the scale, they have hand weapons, consisting of rifles, pistols, etc. Included in the term Ordnance is everything pertaining to the above, and to its design and manufacture, and we thus see that the ordnance offices of the Great Powers of the world spend very large sums of money, and control what is perhaps, on account of the great variety of the range of the contributory sciences, as complex an output as is to be found.

In speaking of ordnance people generally have in mind a gun alone, but they should consider with the gun the means of resisting its attack. The means of resisting the attack of guns consists in "cover." Ships carry over their principal parts and guns, steel armor plates, while lines of skirmishers on shore seek cover behind such natural objects as each individual skirmisher can find. The art of resisting the attack of guns, then, may be said to lead to two extremes. In the one the important things are concentrated into a small space and are covered with armor



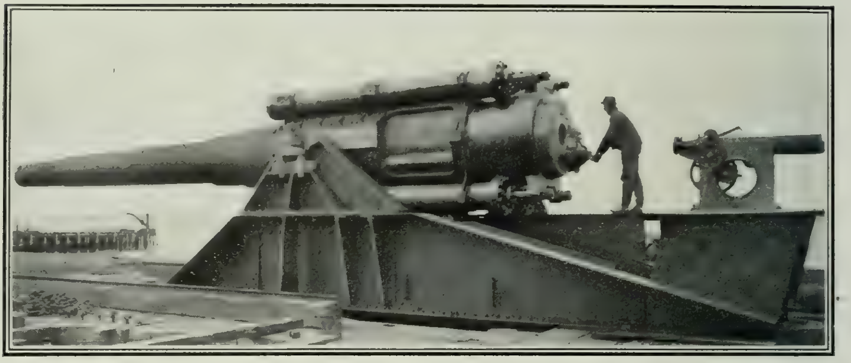
THE ARMOR-PLATE ROLLING MILL AT KRUPP'S, ESSEN, GERMANY.

plate, or stone or earthworks, if on shore. At the other extreme we find the dispersion of the skirmish line, or at sea, the "clouds of small vessels," which some people would prefer to build rather than battleships. Not many years since it was thought by some that it was better to build fifty torpedo boats costing $100,000, rather than one battleship costing $5,000,000. No doubt the torpedo boat, with her deadly torpedo (representing sub-aquatic ordnance), if she can lay out the game in advance, can get the better of the battle-ship. But the view is prevalent now that, while there should be some torpedo boats, the bulk of the money and effort put into naval and coast defenses should go into battle-ships and fortifications. The battle-ship can go anywhere, while the torpedo boat, because she cannot carry much coal, is tied to the home port, and in bad weather, when the battle-ship is comparatively steady, the torpedo boat would, at any speed, tear herself to pieces in the heavy seaway. In the same way, in land defense, the bulk of the money and effort is now put into permanent defenses and field artillery. Nations have also supplies of ammunition and portable weapons, but in the preparation which goes on in peace time the bulk



12-INCH GUN ON DISAPPEARING CARRIAGE; BETHLEHEM STEEL COMPANY.

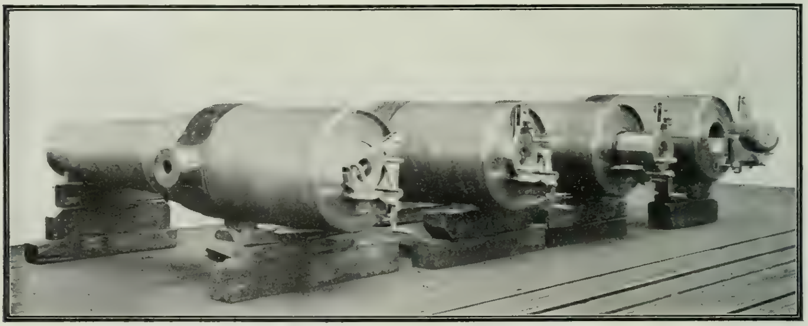
Characteristic weapon of U. S. coast defense. Weight 50 tons. The lever arms permit the gun to drop 9 feet behind a parapet after firing. It is returned to battery by a counterpoise.



13-INCH GUN OF THE AMERICAN NAVY, WITH HYDRAULIC RECOIL CYLINDERS.

of the money and attention goes to putting in the great land defenses on the frontiers.

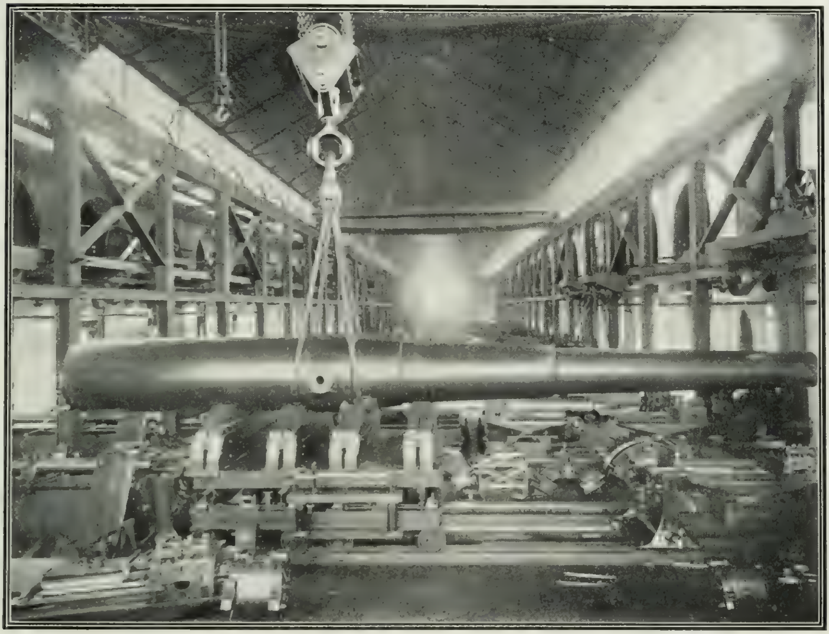
There is, probably, no feat of modern engineering so wonderful as the building and equipping of great battle-ships. Not only must everything in them be strong, serviceable, and compact, but, since every ton of load the ship can carry is so much offensive or defensive power—that is, is so much weight in guns or armor—everything must be as light as possible, and the full power of everything put into the gun must be utilized. If of two guns of a certain weight one will strike a more effective blow than the other, then that gun is the one to choose. Similarly the armor of a given thickness which will offer the greatest resistance to penetration is the best and must be had at any cost. If we go into a modern battle-ship and go over her, there are no places in her which would so fill us with wonder, and, it may be added, a certain amount of uneasiness, as her engine room and her gun turrets when in operation. In the latter, if she is a large ship, she will carry 12-inch or



A GROUP OF 12-INCH MORTARS, AT THE BETHLEHEM WORKS.

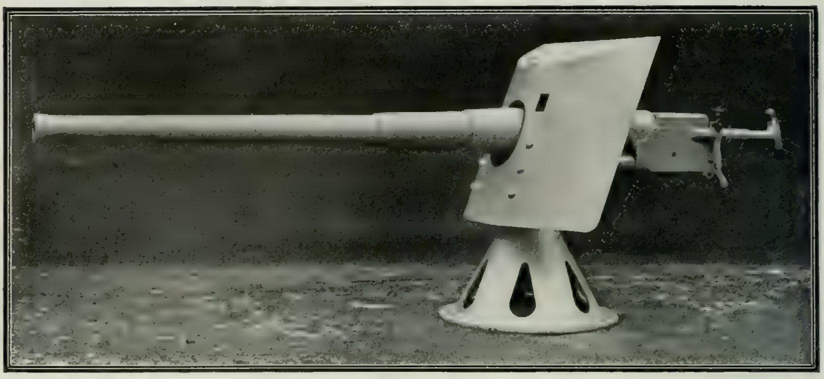
The mortars throw a projectile weighing 850 lbs., at very high angles, with the purpose of attacking an armored ship by piercing her deck.

13-inch guns, probably, and these, weighing from 50 to 60 tons—about the weight of a fair-sized locomotive—will, when they are fired, be projected to the rear at a rate of about 25 feet per second, or say 17 miles an hour. By their hydraulic recoil brakes, in which resistance to the motion of a piston in a fluid-filled cylinder is by means of a rod utilized to restrain the gun's recoil, the gun will be stopped in about 36 inches, and will be returned to its firing position by a powerful coiled spring. So quick is the stroke of recoil and return that the eye fails to appreciate it, and devices are used in gun turrets to prevent the gun from being loaded twice, from a mistake on the part of the gunners in supposing that the gun had been fired when it had not. Nothing, perhaps, gives an idea of the immensity of the forces in play so well as the snapping of a 50-ton weight to the rear and forward again so quickly that the human eye can hardly see it. On land, again, we have the so-called disappearing mountings, on which a gun is carried on a pair of long rocking levers. Upon firing, the gun of 50 or 60 tons is dropped behind a parapet, and, upon throwing a lever, after the gun has been loaded in its lower position, the gun rises above the parapet again, and is once more ready to be fired.



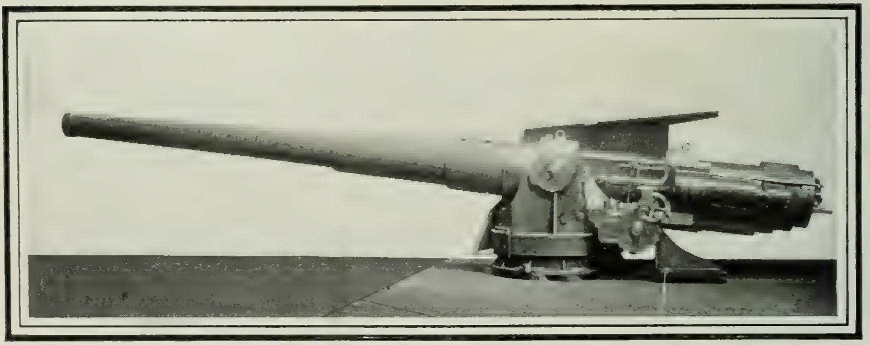
THE GREAT 16-INCH GUN AT THE WATERVLIET ARSENAL, N. Y.

By courtesy of Col. J. P. Farley.



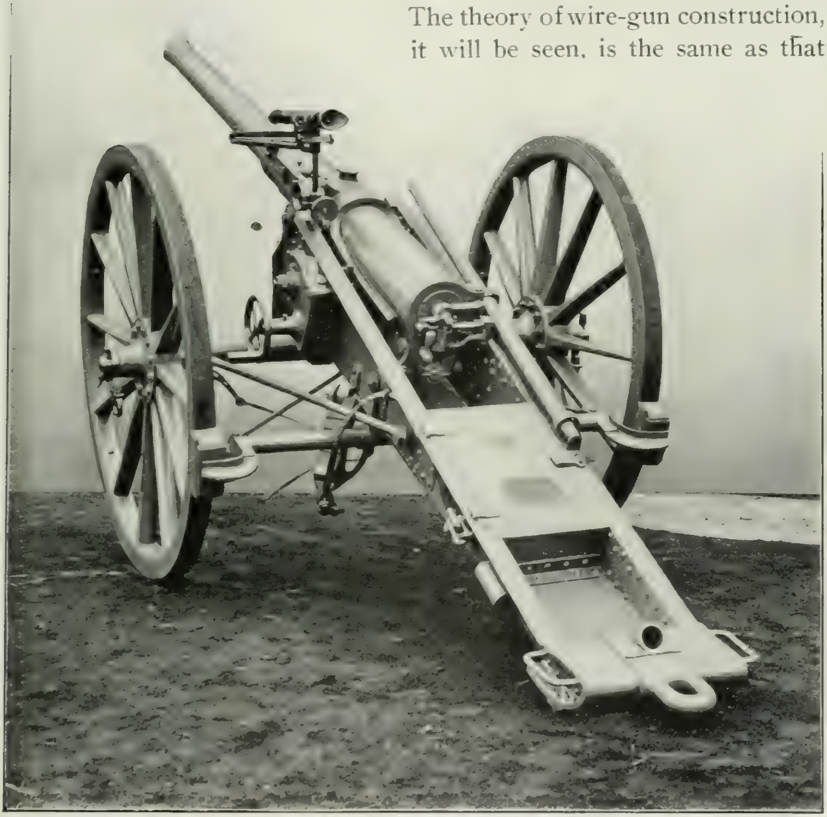
14-POUNDER 3-INCH SEMI-AUTOMATIC GUN.
Vickers, Sons, & Maxim, Ltd.

At the other end of the scale we have the "automatic" guns. The automatic feature has not been used much in any gun throwing projectiles of more than one or two pounds weight. These it will throw, in the case of the smaller calibers, at the rate of several hundred a minute, so that the bullets can be directed by the gunner to any point, in the same way that he would direct a stream of water from a hose at a point. Still a great many military and naval men, not to say the majority, do not believe in the use of the automatic feature on even one-pound guns, because an automatic gun must weigh more than one that is hand loaded, and because it fires ammunition away so rapidly that it must run out of its ordinary supply in a few minutes. Still, an automatic gun that will throw projectiles at such speed, under certain circumstances may be a most useful weapon. To give an idea of this effect, it may be stated that it is easy to cut down large trees with the stream of bullets fired from an automatic gun, using projectiles such as are fired from ordinary shoulder guns.

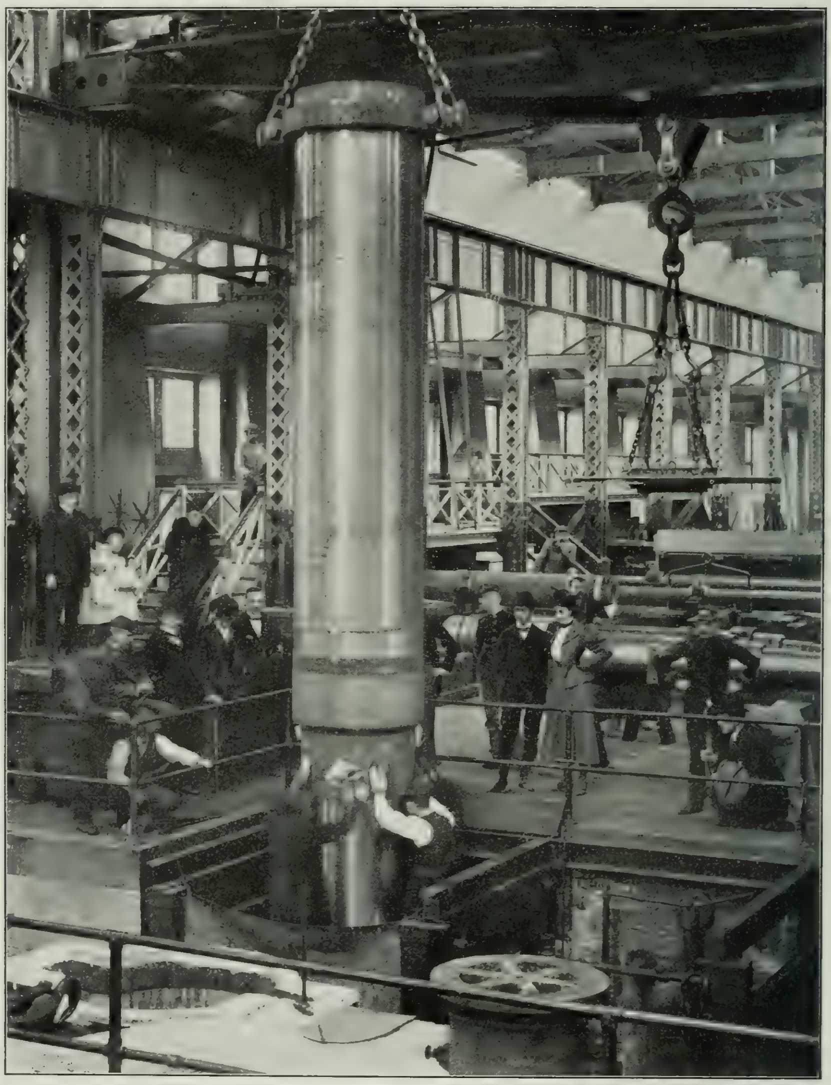


SCHNEIDER-CANET 24-CENTIMETRE RAPID-FIRE GUN ON NAVAL MOUNTING.

Guns are nowadays all built of steel, and successive tubes are shrunk on, one outside of the other, and thus a greater strength against internal powder pressure is reached than could be reached with a gun of one piece. Also, guns are built of wire sometimes, and the wire gives a greater margin of hoop or circumferential strength. On the other hand, a wire gun is less strong lengthwise, and the opponents of wire-gun construction say that guns are more apt to fail lengthwise than circumferentially. This is a large question, and one upon which a great deal of talent has been engaged for many years. It may be stated that neither the army nor navy of the United States, France, Russia or Germany, uses wire guns, while in England they are used. The theory of wire-gun construction, it will be seen, is the same as that



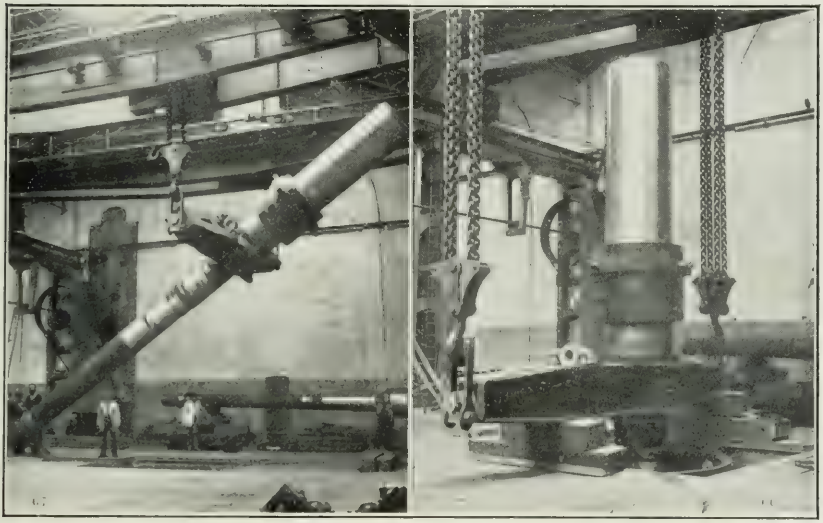
12-POUNDER 40-CALIBRE GUN FOR FIELD SERVICE, ELSWICK-BUILT.
A battery of six of these guns was built for Lady Meux, who presented them to Lord Roberts. They were served in South Africa by a volunteer battery from Elswick. Muzzle velocity, 2,230 feet per second; range, 9,000 yards. The gun recoils in the line of fire, and recoil of the carriage is entirely suppressed by brake shoes and spade.



SHRINKING A JACKET ON A 13-INCH GUN TUBE, WASHINGTON NAVY YARD.

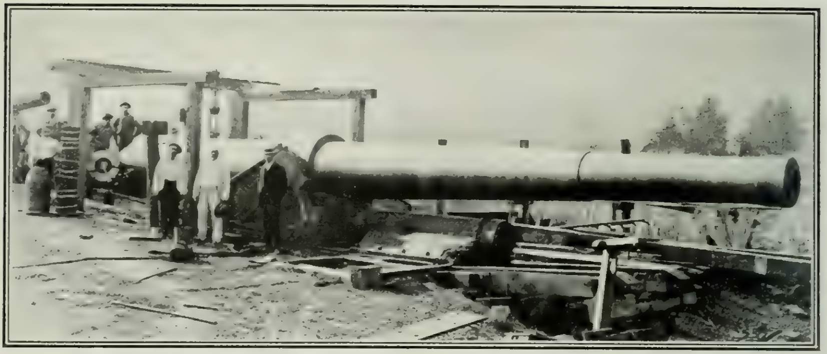
of using hoops shrunk together, except that with the wire you have, so to speak, a great many hoops, and the tension of successive layers as you go outwards is obtained by the pull on the wire in winding it on the gun, instead of by making the hoop which is to go on the outside of the gun smaller than the piece which it envelops, heating it, slipping it into its seat, and allowing it to cool there and grip the internal part.

Since each successive filament, as you go outwards in a gun's walls, pulls less and less when the powder pressure distends the gun's bore, it is evident that it avails very little to make the walls thick beyond a certain point. At present the walls are from one to one and one-quarter times the diameter of the bore. Also, theoretical reasoning indicates that the strength of a gun (a thick hollow cylinder) cannot be made greater than about 1.4 times the elastic strength of the metal of which the gun is made. Gun steel now has an elastic strength of from 45,000 to 65,000 pounds per square inch, with an elongation in a 2-inch bar of from 25 to 15 per cent. of its original length. There is a constant tendency to use harder and stronger steel.



PLACING AND SHRINKING ON THE HOOP OF A 66-TON GUN FOR THE JAPANESE GOVERNMENT, AT THE SCHNEIDER WORKS, LE CREUSOT.

The powder pressures in guns now rarely run over 37,000 pounds to the square inch, and it is doubtful whether, with modern powders, so high a pressure can be used, as modern powders are liable, when too great a weight of them is exploded in a gun-chamber of fixed size, to give dangerous pressures. It may be stated that all powders have *critical pressures,* and that when, by reason of employing too high a "density of loading" (that is, filling the chamber too full) these pressures are reached, variable, abnormal, and violent pressures which cannot be predicted, will supervene. The critical pressure of modern powders is lower than that of old powders. Modern smokeless powders cannot be used in large guns with safety at so great a pressure as 50,000 pounds per square inch. The older forms of powder, such



THE 18-INCH GATHMANN TORPEDO GUN.
Designed and built by the Bethlehem Steel Co. To the left and rear is seen the partially pointed projectile, and next to it the regular powder charge.

as that which was called brown powder, of only a few years back, could be used at as high a pressure as that just stated, but no one would like to use the approved modern powder, which is pure nitro-cellulose, higher than perhaps 35,000 pounds to the square inch, and those modern powders which are made up partly of nitro-cellulose and partly of nitro-glycerine could not be used at as high a limit as this. The limit for them does not exceed 30,000 pounds. When it is added that guns, even of large size, can be made sufficiently strong to withstand, with proper factors of safety, pressures of 40,000 to 45,000 pounds per square inch, while modern powders cannot be relied on to give steady and uniform pressures when worked to this point, it becomes apparent that much is to be desired in the powder. If powders are worked near their critical pressures, the products of combustion are believed to combine in differing ways, producing different "orders of explosion," and what are called "wave pressures" appear. Under these circumstances, abnormal and destructive pressures are created.

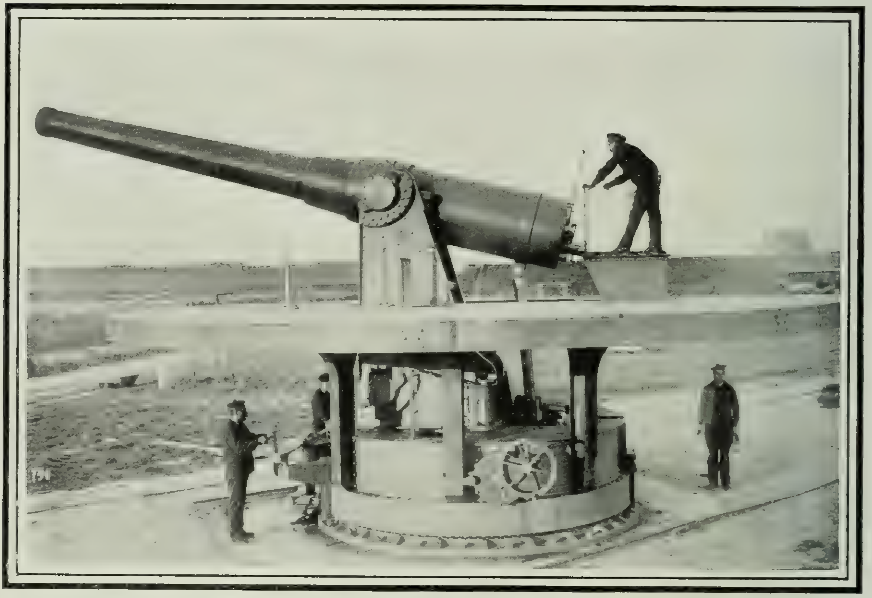
6-INCH AND 7.5-INCH GUNS AT THE PROVING GROUNDS.
Vickers, Sons, & Maxim, Ltd.

Besides the powder just referred to, which is that used for propelling the shot out of the gun and giving it its destructive energy, there is also the powder which is used to burst the shell. The qualities required of this latter are obviously different from those of the propelling powder. The former should give a long push to the shot, thereby propelling it without too great a strain on the gun, while the latter should act very suddenly and blow the projectile into small fragments. Late developments have led to the use of high explosives, generally some form of picric acid, for the loading of shells. These are fired by suitable fuse, at the proper moment, and the whole arrangement of the details of the shell, its bursting charge, and the firing of the latter, constitute the most difficult part, perhaps, of ordnance.

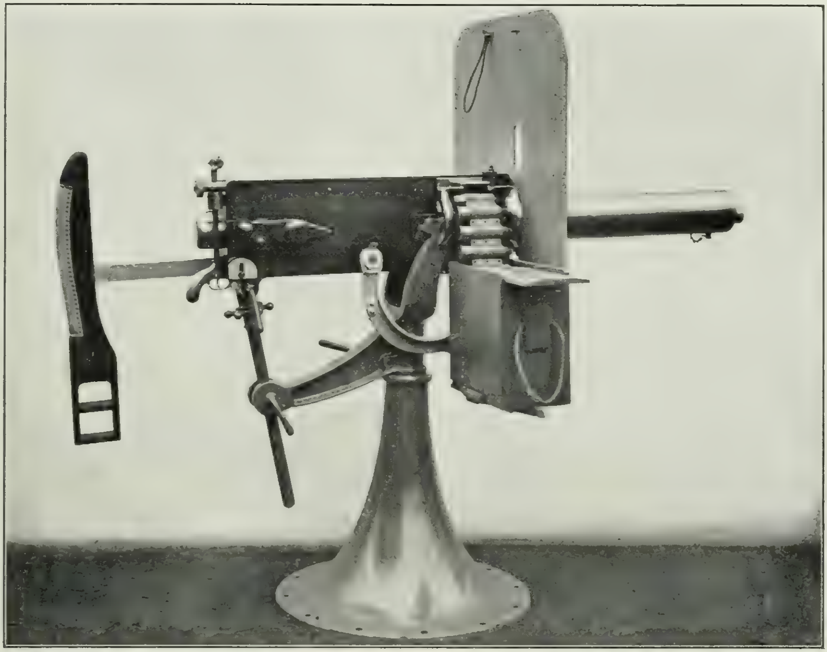
A 14-YEAR-OLD BOY SEATED IN THE BREECH OF THE GATHMANN 18-INCH TORPEDO GUN.

The photograph shows the velocity screens and the tunnel cut in the rock by the fire of projectiles. The view is at Redington, the proving ground of the Bethlehem Steel Co.

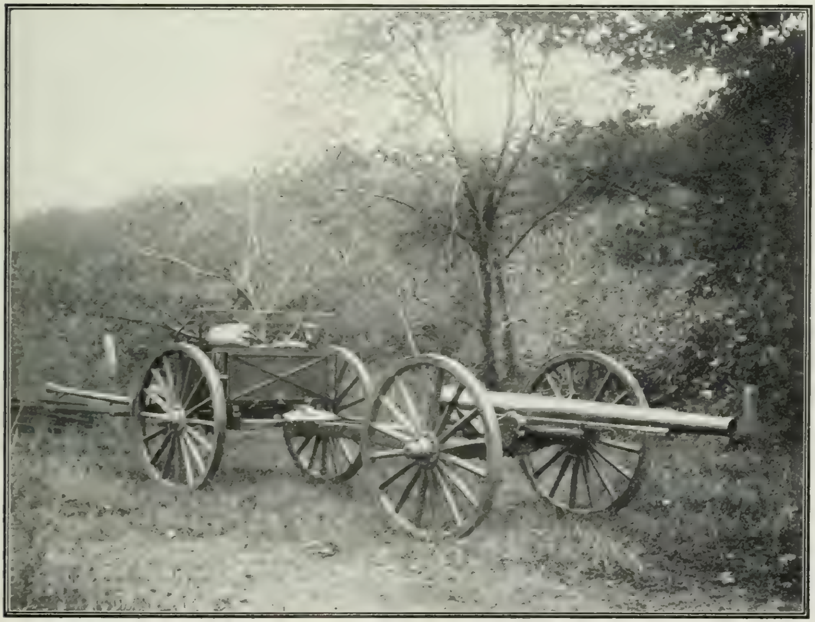
In saying just above that the propelling charge of the gun should push the projectile out of the gun with a long push rather than a short violent one, we have not exhausted the matter by any means. Modern powders are progressive, as it is called. That is, they burn in the chamber with comparative slowness, and supplement the pressure on the base of the rapidly advancing shot by fresh additions of gas, until the shot is out of the gun. In guns suitable for powder of this class, the length of bore must be great and the powder chamber should be large in diameter. This necessitates obviously a heavy gun. In the older guns, which used black powder, the chambers were not so large nor the guns so long. Any one visiting the old arsenals of Europe and examining guns made 200 or 300 years ago, would see that their system in this regard was similar to that of the present day. We are now, by means of long bores and large powder charges, contained necessarily in large chambers, using the gun's weight economically, while 40 years ago guns were much less strong around the muzzle, the chambers were smaller, and the guns shorter, so that economy in ammunition was striven for rather than economy in gun's weight. It is a little curious that at the present time we are moving in ordnance in the opposite direction to that followed in the evolution of steam engines. We are using guns, or rather the powder in the gun, non-expansively. Neither are we materially raising the pressure in guns, while steam pressure is rising continually, and it would appear that, as the steel grows stronger, the powder pressures should be raised. This, however, is a question of the powder and its critical pressure, already noted.



SCHNEIDER-CANET GUN OF 27-CENTIMETRES MOUNTED ON DISAPPEARING CARRIAGE.

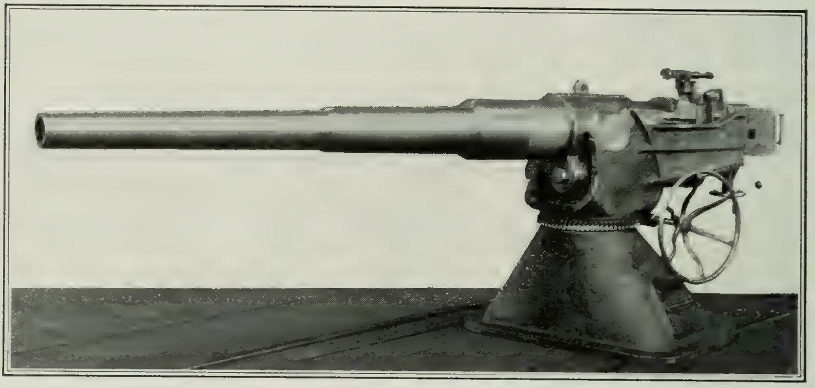


37-MILLIMETRE AUTOMATIC MAXIM GUN ON CONE MOUNTING.

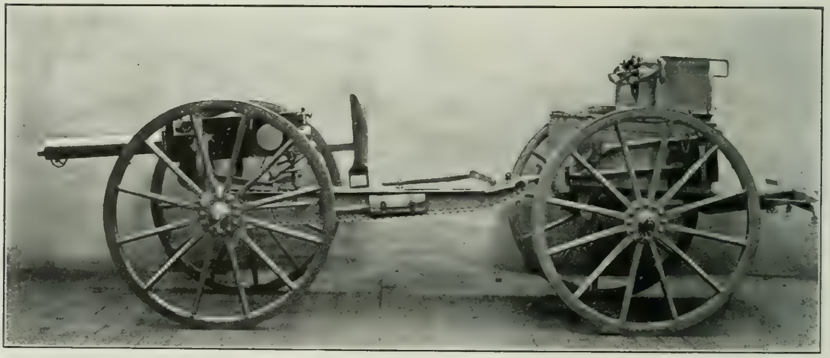


BETHLEHEM STEEL COMPANY'S 3-INCH FIELD GUN AND CARRIAGE, WITH LIMBER.
Weight fully equipped, with 44 rounds, 3,958 pounds.

No less important than the gun is the gun mounting or carriage. Indeed there is more scope for improvement and betterment in the carriage than in the gun, and there is a particularly interesting development now going on in field-gun carriages. Formerly field guns were fixed to their wheel axle, and when fired the gun ran with the axle and wheels to the rear, a distance of twenty or more feet, depending upon the obstructions on the ground. At present, however, everybody is demanding what are called rapid-fire field guns. In these the gun recoils on the axle, with a hydraulic recoil cylinder to stop it and return it to battery; and in consequence of this elastic joint, the gunner may sit on the trail of the carriage, the wheels remaining stationary on the ground, and the rate of fire is accelerated from four or five rounds per minute to twenty rounds per minute. The reader will note that the old fashioned *rigid* carriages, as they are called, which recoiled on the ground, had to be run back by hand to their position before firing—a

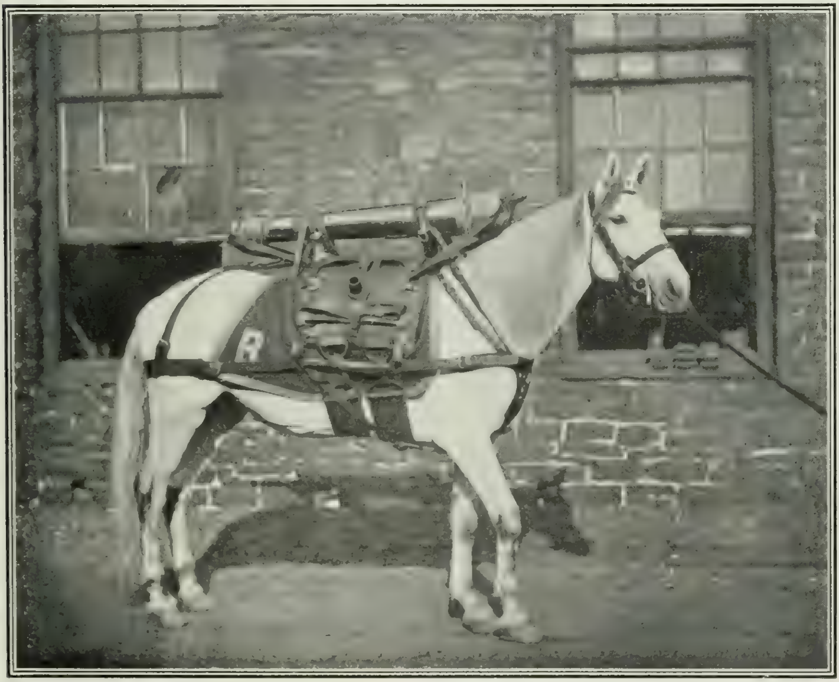


4-INCH GUN FOR U. S. NAVY, BUILT BY THE BETHLEHEM STEEL CO.



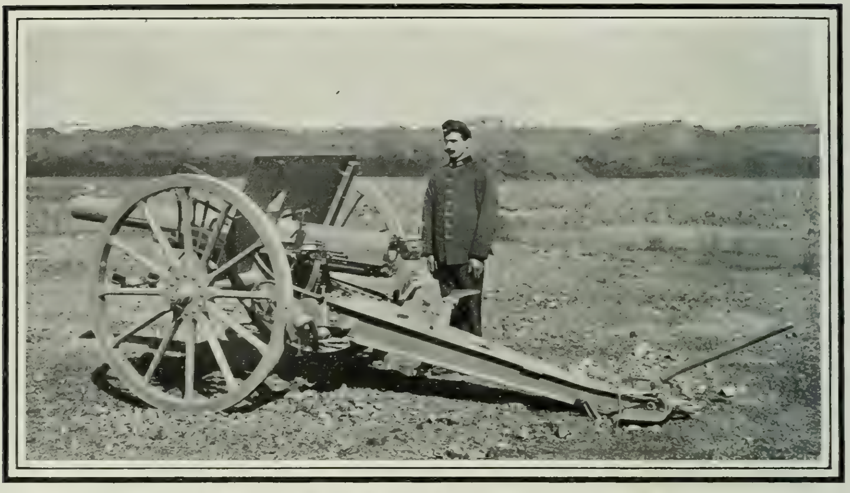
37-MILLIMETRE FIELD EQUIPMENT.
Vickers, Sons, & Maxim, Ltd.

laborious and time-consuming operation—between each fire. While not increasing the total weight of the equipment behind the horses and maintaining the effectiveness of the gun, it is striking to observe that this incorporation of what is called rapid fire into field artillery has led to enabling one gun to deliver as many shots as four could formerly. Of course the modern gun with the elastic recoil arrangements is more complicated than the old rigid gun, but if it can fire four or five times as often, it would appear that the modern complicated gun has come to stay, and that the men who handle it must become mechanics.



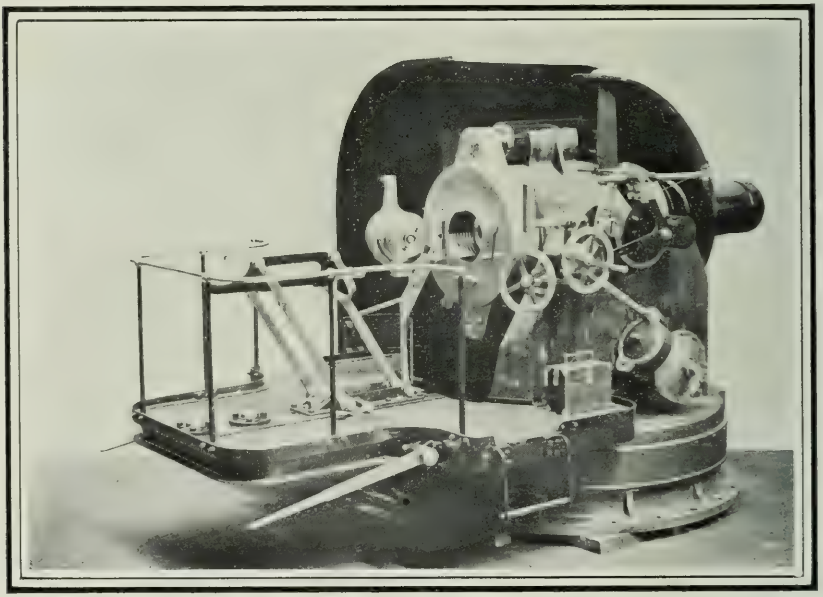
BETHLEHEM STEEL COMPANY'S 3-INCH MOUNTAIN GUN STOWED FOR TRANSPORTATION.

The mountings for ship guns and guns in coast fortifications are very much the same, and are so designed and constructed as to throw into the power of one man, in so far as possible, the whole control of directing the gun at the desired target and firing it when ready. The loading of the gun and the opening and closing of the breech block is performed to the rear of the man firing it, and therefore out of his sight, and certain interlocking arrangements in the firing apparatus are so devised as to prevent him from firing the gun unless the breech block is fully closed. Admiral Lord Collingwood, who was second



THE SCHNEIDER-CANET 75-MILLIMETRE RAPID-FIRE FIELD GUN, MODEL OF 1901.

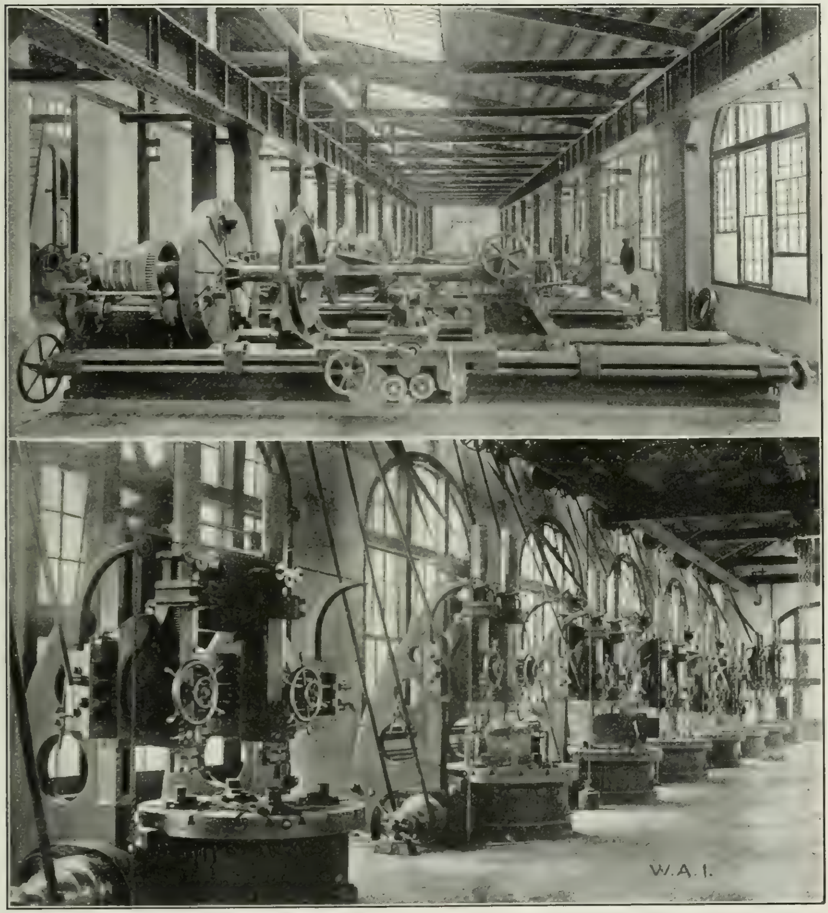
in command to Nelson at the battle of Trafalgar, was in the habit of telling his men that, if they could fire three well-directed broadsides in two minutes, they were certain of victory. Their guns weighed about 2,400 pounds. The modern 6-inch breech-loading gun, which weighs



24-CENTIMETRE SCHNEIDER-CANET HOWITZER OF 10 CALIBRES ON NAVAL CARRIAGE.

Schneider & Cie, Le Creusot, France.

12,000 or 15,000 pounds, has been fired eight times within a minute at a target about 1,500 yards distant, probably quite three times the distance in Lord Collingwood's mind, and struck the target each shot. The difference here shown is due principally to the mounting. It is due, in some degree, to the fact that the modern gun is breech-loading, but the quicker rate of fire must be ascribed in large measure to the excellence of the mounting.

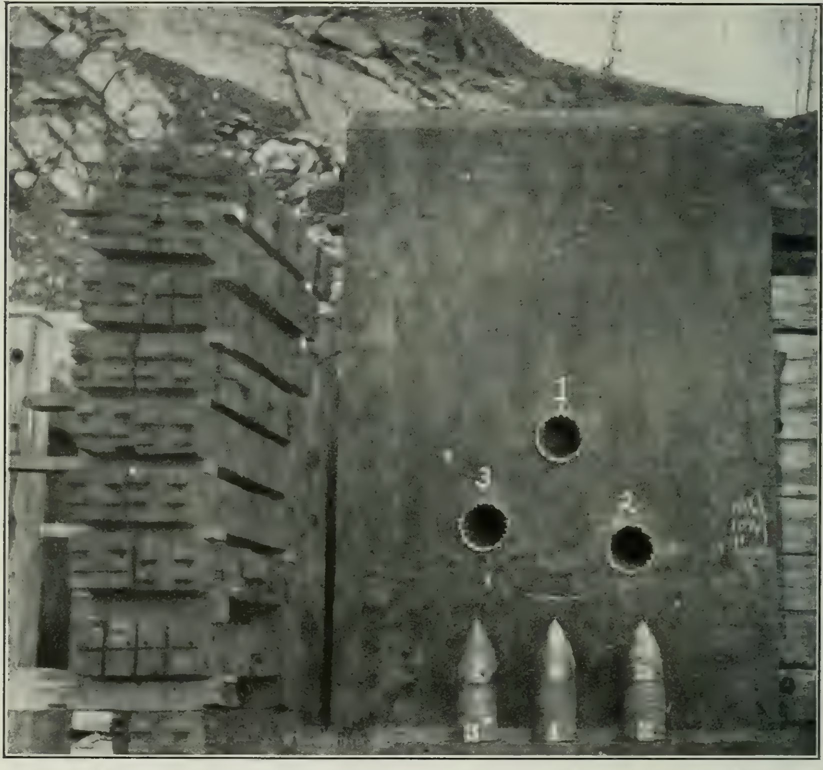


TWO VIEWS IN THE U. S. ARSENAL AT WATERVLIET, N. Y.

The upper picture shows the gun-jacket boring and turning lathes, the lower a row of boring and turning mills. The tools are of Niles make.

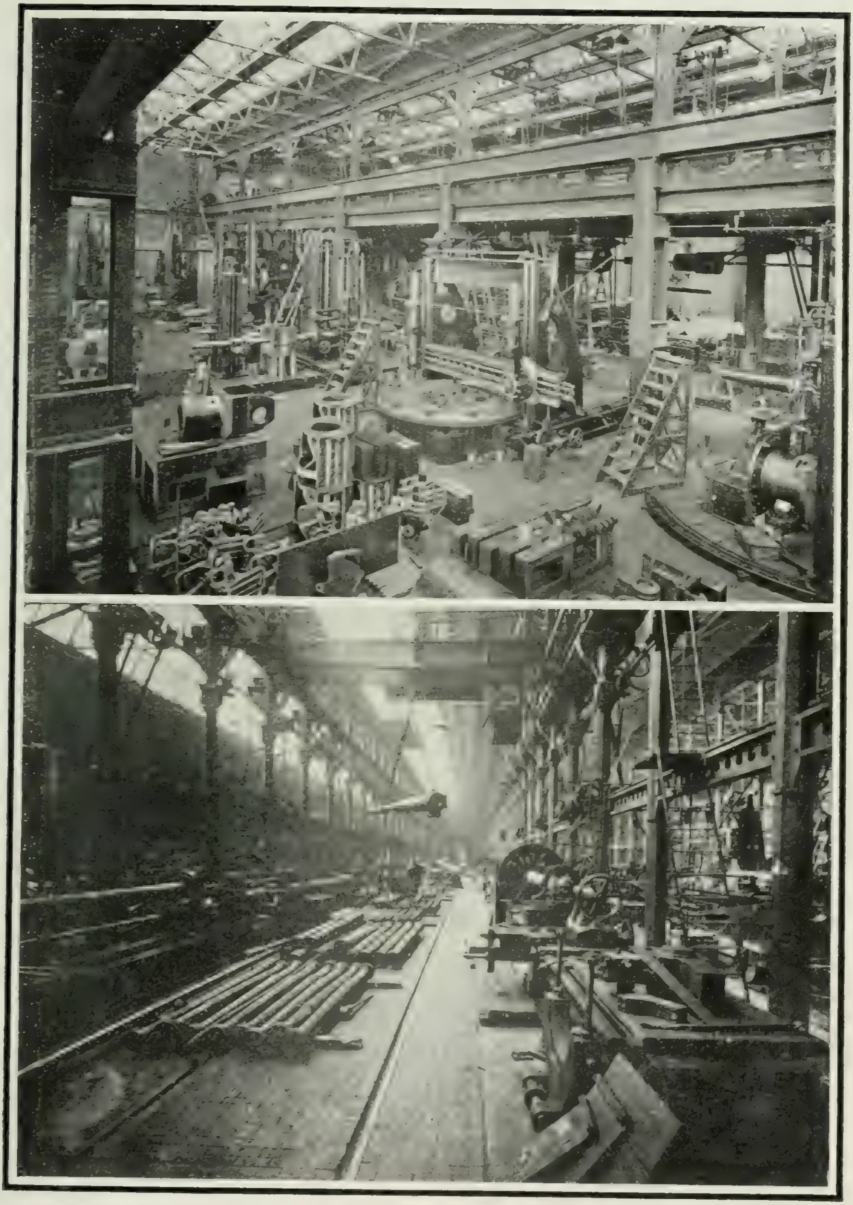
Armor plate, which now constitutes the protection universally employed by ships of war and in many land fortifications to resist the attack of projectiles, is super-face-carbonized and hardened steel.

Some thirty years ago what was called *compound armor* was used in Europe. This consisted of a face of hard steel burned or welded onto a backing of comparatively soft metal; and there exists a close analogy between this and the present super-carbonized and face-hardened armor. In the compound variety, however, the joint between the soft and the hard metal was never good, and when an armor plate was struck by a shot, large areas would be stripped of the hard face. The hard face, produced by super-carbonization, is much more adherent, but, it must be added, is not so thick as that which can be produced with compound armor. Upon the whole, however, modern armor is far more resisting than that of former times.

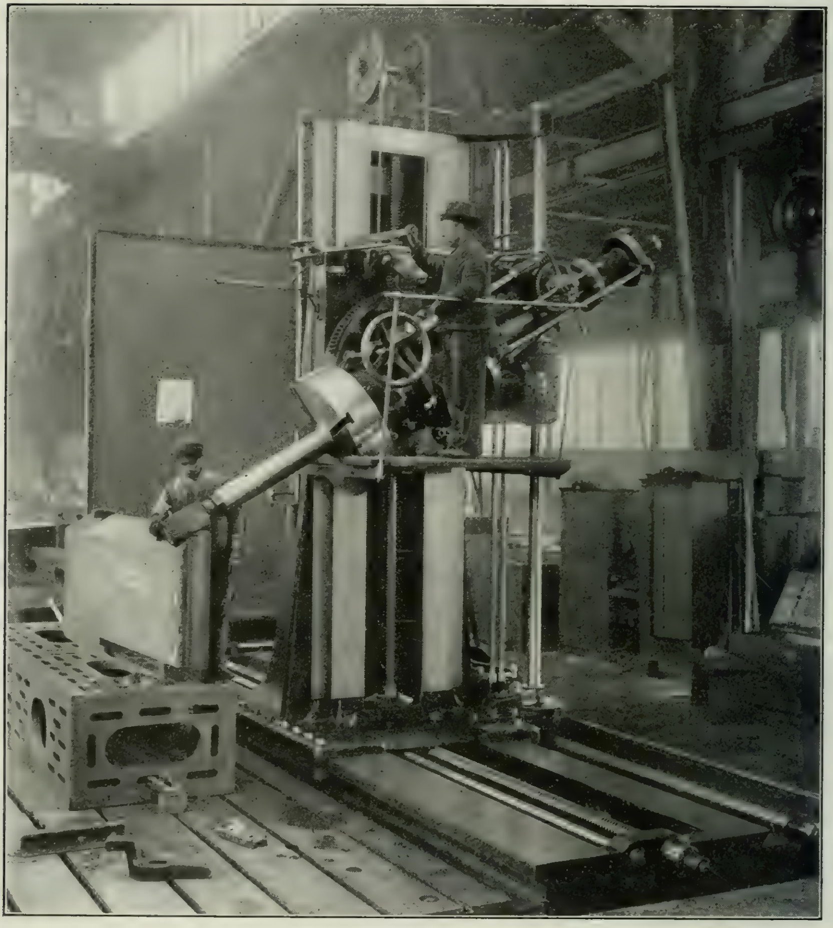


TEST PLATE OF THE TURRET OF THE U. S. S. MAINE, SUNK IN HAVANA HARBOR. These plates were not face-hardened, but were homogeneous steel. The "fringe" which squirted toward the gun is well shown. Photograph taken at the Bethlehem Steel Co.'s Redington proving ground.

The office of the hard face in armor is to cause the rupture of an attacking projectile. The projectile makers are striving so to design the form of the projectiles, and so strengthen them, that they can meet



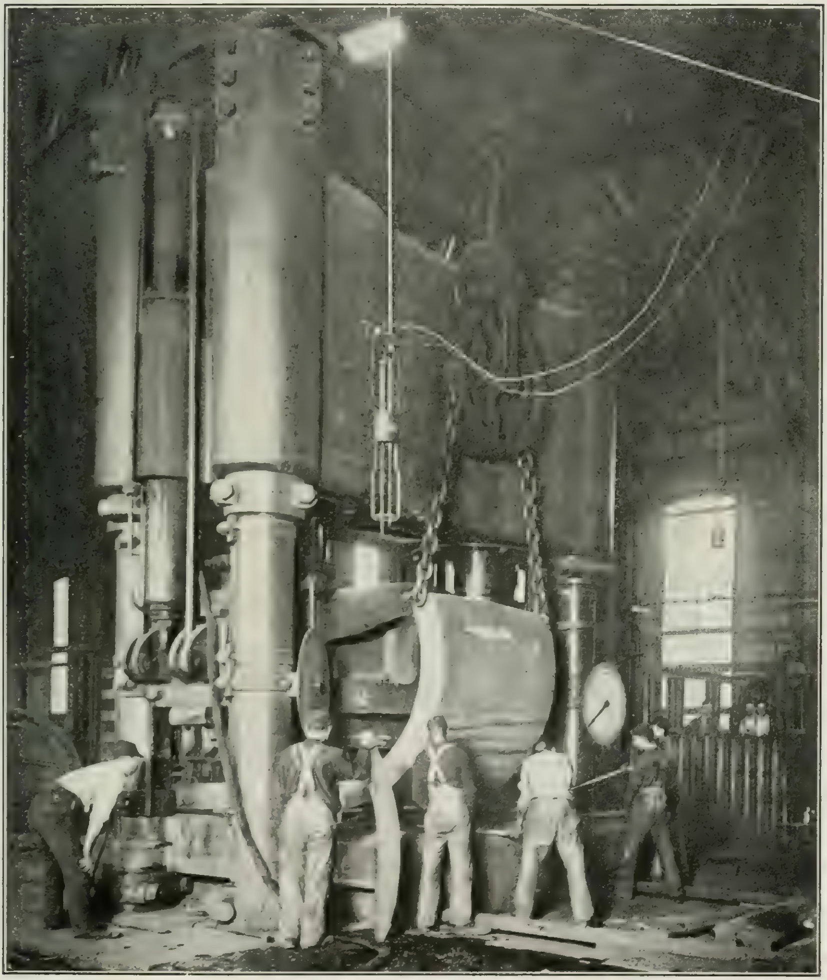
VIEWS IN THE ERITH WORKS OF MESSRS. VICKERS, SONS, & MAXIM, ERITH, KENT.
Above is the carriage department; below, the gun-mounting department.



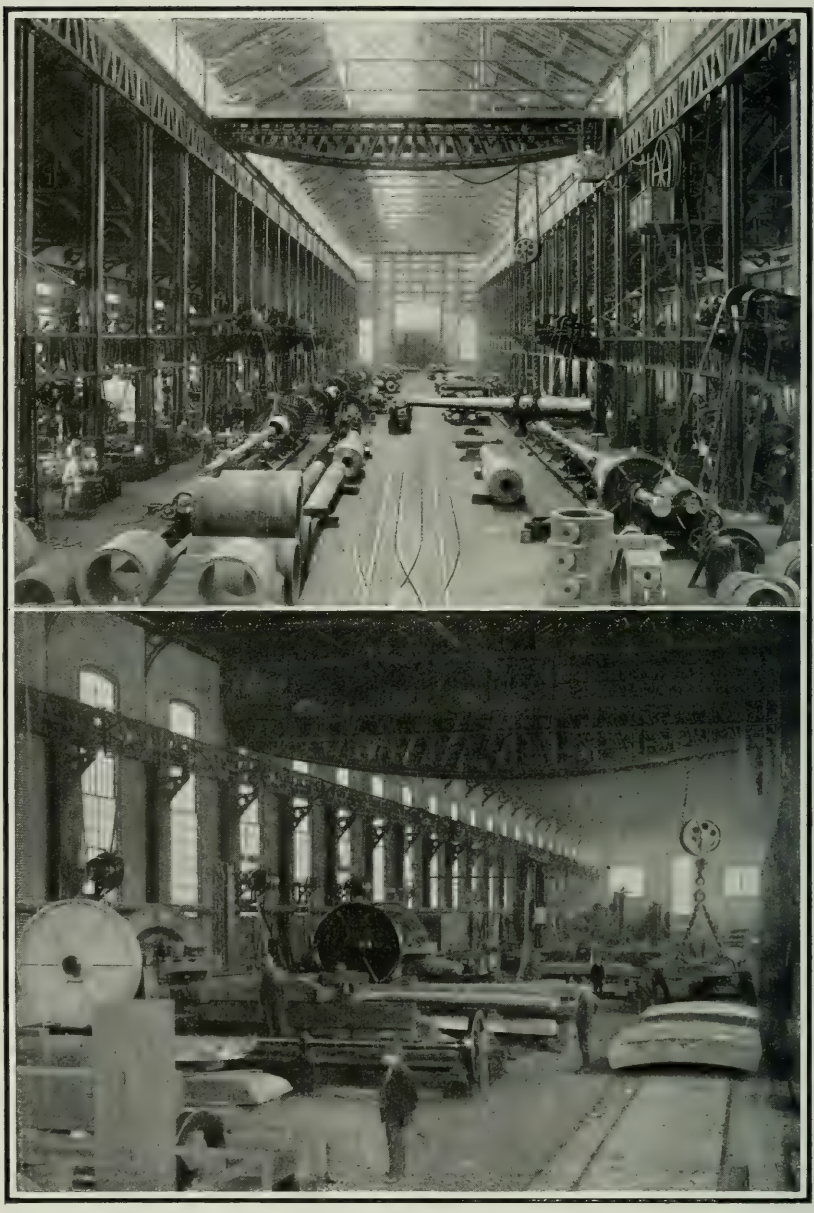
MILLING AN ARMOR PLATE TO THE PROPER BEVEL.
Fried. Krupp Works, Essen, Germany.

the glass-hard 2-inch-thick face of an armor plate (say from 4 inches to 12 inches in total thickness) and break through it before they themselves are broken. To this end the working end of the projectile—its forward end—is glass-hard, while its rear, like the rear of an armor plate, is soft and tough, and will yield and not break. Thus between the armor plate and the projectile there is a constant rivalry, and in the past fifteen years the armor plate has become from two and a half to three times more resisting, while the projectile has not improved so much. Owing to improvement in design and in material and tempering the projectiles have advanced somewhat, and in the use of the soft cap on their noses, rediscovered some few years back, they have materially gained.

Iron armor first came to be used about the year 1860, simultaneously in America and in Europe. In the American civil war, as is well-known, it was used to a great extent. At that time so-called laminated armor was used, consisting of a number of plates 1 inch or 1½ inches thick. The metal of these plates was comparatively soft. Following these came thicker plates, in which the whole thickness of armor was in one solid piece. This was a great improvement, and plates of as



7,000-TON ARMOR-PLATE-BENDING PRESS, BETHLEHEM STEEL CO.

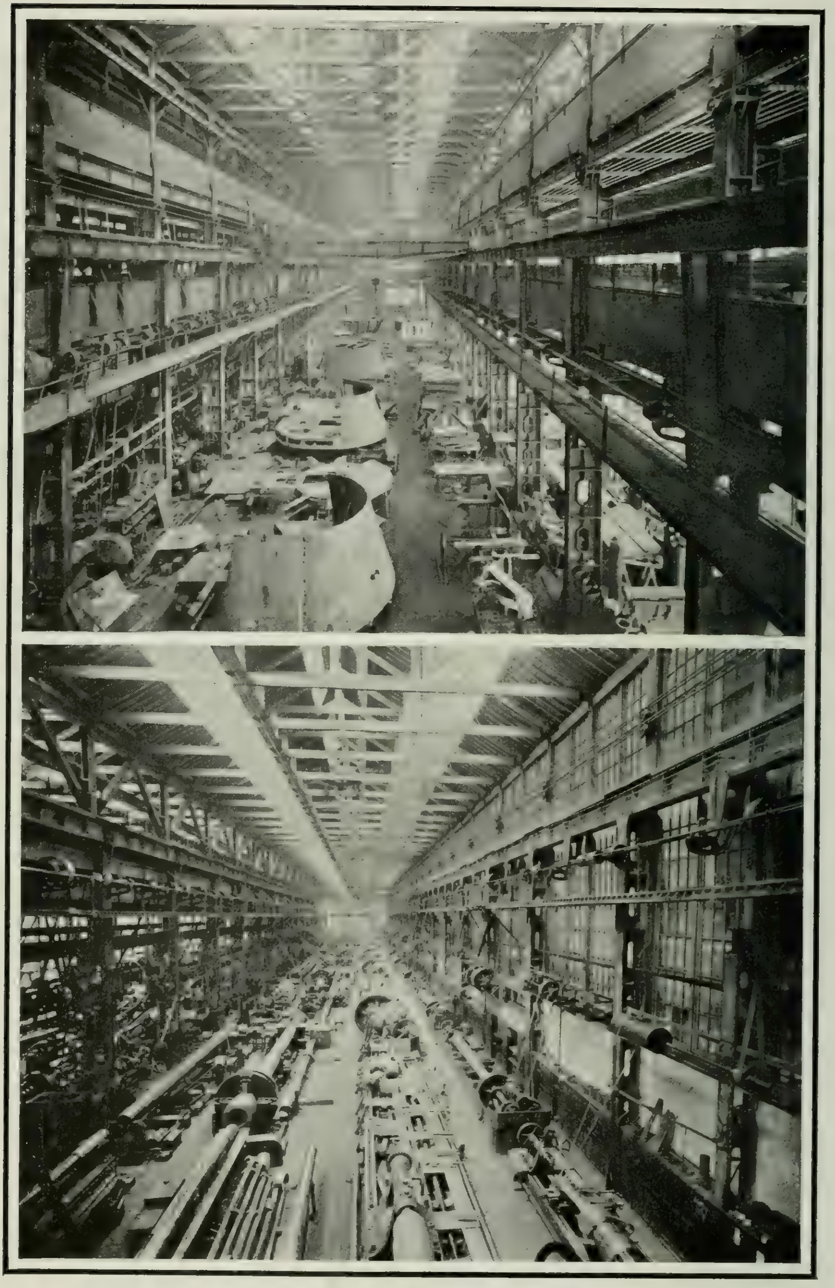


THE UPPER VIEW SHOWS THE GUN SHOPS AND THE LOWER VIEW THE ARMOR-PLATE SHOPS, BETHLEHEM STEEL COMPANY, SOUTH BETHLEHEM, PA., U. S. A.

much as 20 inches thickness have been used. The use of compound armor and of super-carbonized faces came later, and they are manifestly improvements on the so-called homogeneous armor, which is of one degree of hardness throughout.

The question of getting a sufficient supply of ammunition to the guns, whether in the field or on the broadside of the ship or in her turret, is perhaps the most difficult of all tasks set the ordnance engineer. Not only must the ammunition be moved rapidly, but it must be moved safely and securely, and the bringing up from the bottom of the ship to her very top, that is, carrying through the 30 feet between her magazines and her turrets, a couple of rounds consisting each of a 1,000-pound shot and about 300 pounds of powder, in each minute, is not easy to arrange for. It may be noted in passing that most of the appliances are electric, and that interlocking arrangements must be provided to prevent the performance of operations in the wrong way—to prevent, for example, the gunner from attempting to raise or lower the breech of the gun while the charge is being rammed into it. On land, the supply of ammunition, from that of the skirmish line, now attempted by means of dogs, to that of the 12-inch rifles in the coast fortifications, constitutes also a most difficult task. Indeed, as every

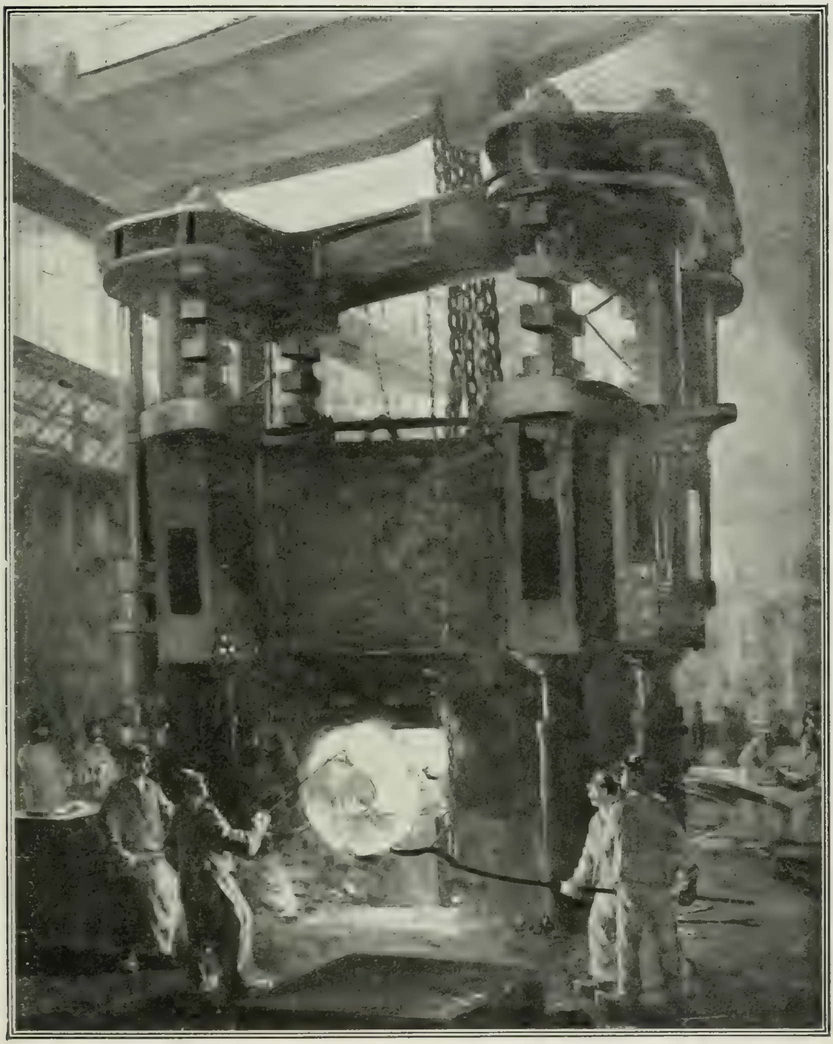
INTERIOR OF THE KRUPP ARMOR-PLATE SHOP.



PORTIONS OF THE ELSWICK WORKS, NEWCASTLE-UPON-TYNE, ENGLAND.

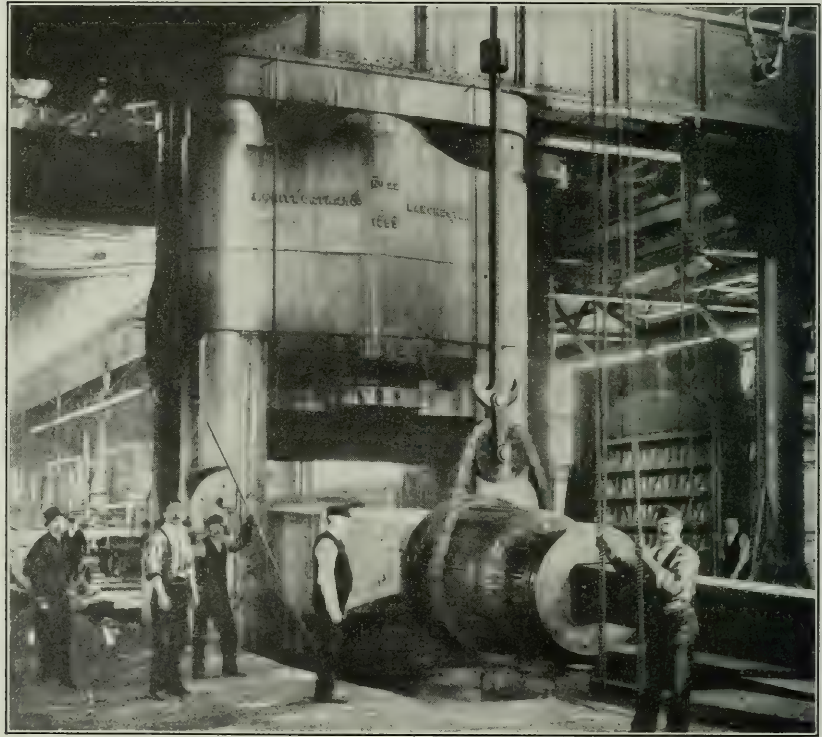
Above is shown the erection of turntables and turrets for 8-inch guns. Below is one of the large machine shops for turning and rifling heavy guns. The shop takes guns from 12 down to 6 inches.

6-inch gun and guns of smaller size may be fired effectively several times a minute, and as each 12-inch turret or barbette gun may be fired once in a minute or in a minute and a half, we may affirm, without fear of contradiction, that the guns are better arranged than are the methods of supplying them with ammunition; for no ship could bring her ammunition up as fast as is indicated. We have an almost parallel difficulty in the matter of coaling ships, and in the delivery of the coal



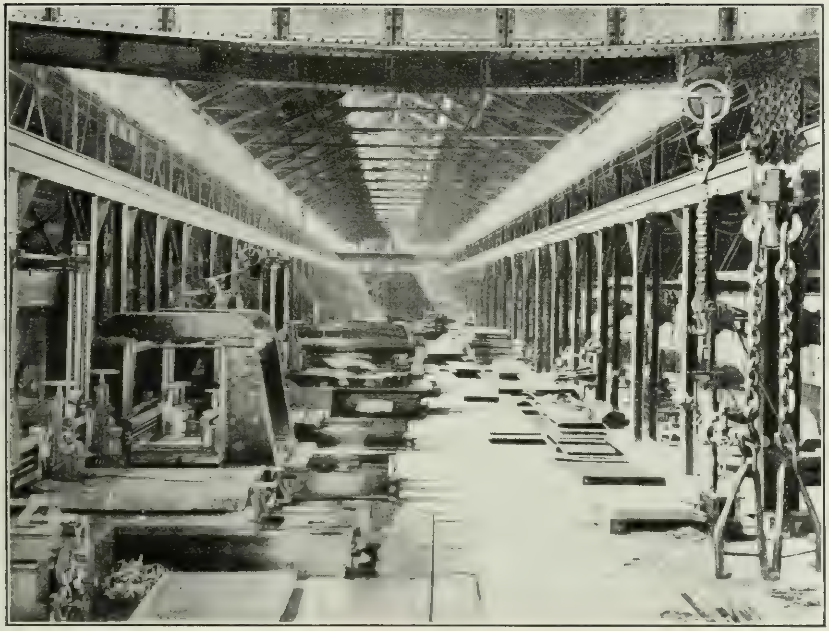
THE 5,000-TON FORGING PRESS, KRUPP WORKS.

to their furnaces, for in many ships coal can be burned up faster than it can be put on board, and in some, under adverse circumstances, it cannot be got to the furnaces as fast as the furnaces can burn it up. Obviously there is no use in putting complicated arrangements leading to quick firing on the guns, unless the ammunition can be brought to the gun fast enough, nor is there any use in putting into the hands of the soldier on the skirmish line a magazine rifle, from which he could fire away all the ammunition which he himself could carry in a very short space of time, unless his ammunition supply can be replenished, and unless he can be taught to use to advantage the ammunition he has. Still, these difficulties of ammunition supply must be overcome, for if one contestant can fire more rapidly than the other he will have a determining advantage, and therefore both will endeavor to be capable of firing as rapidly as may be, and if either side is caught without ammunition, so much the worse for it.

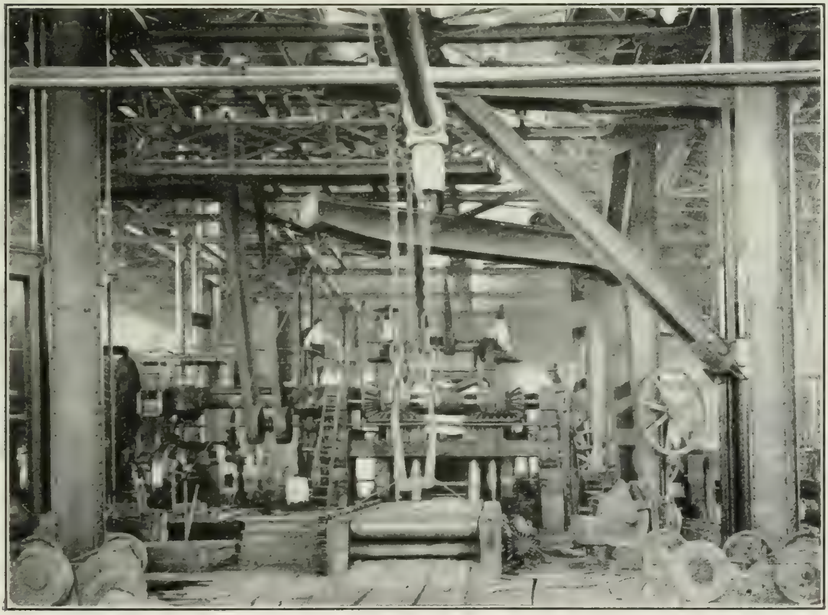


12,000-TON HYDRAULIC FORGING PRESS, ARMOR-PLATE DEPARTMENT OF THE HOMESTEAD STEEL WORKS.

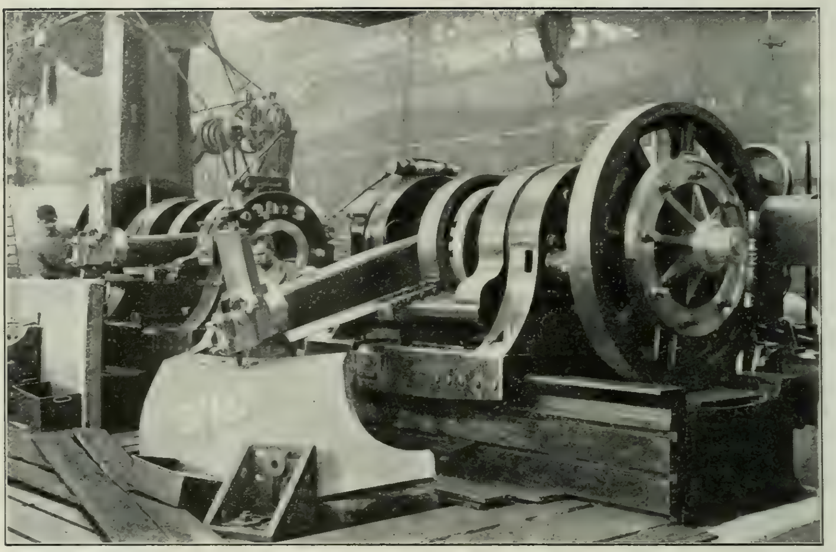
A correct understanding of ordnance engineering may be greatly



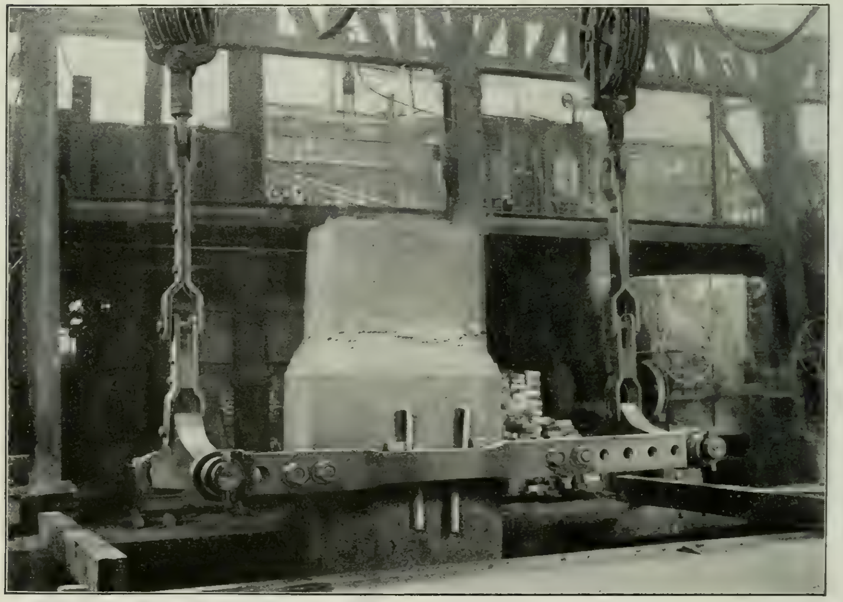
INTERIOR VIEW OF ARMOR-PLATE MACHINE SHOP, HOMESTEAD STEEL WORKS.



ARMOR-PLATE ROLLING MILL, HOMESTEAD STEEL WORKS.



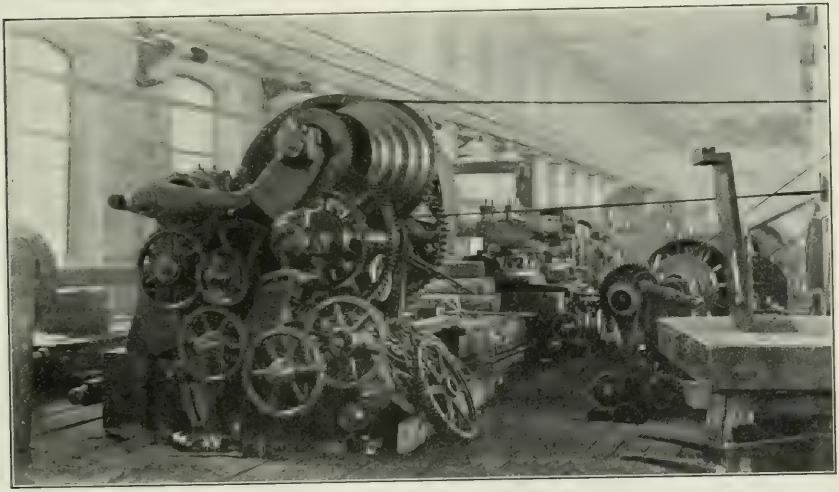
TWO ARMOR PLATES AT THE TWIN SHAPING MACHINE IN THE KRUPP WORKS, ESSEN. The shaper finishes the edges of armor plates either square or at any desired angle of bevel.



222,300-POUND NICKEL STEEL INGOT FOR TUBE OF 16-INCH RIFLE FOR U. S. ARMY.
Bethlehem Steel Company.

aided by the study of the history of guns and protection. The battleship of one hundred years ago—the "line-of-battle-ship" or "seventy-four," as they were called—carried guns which could penetrate the sides of similar ships at from 1,000 to 1,500 yards range. Battleships of the present day, vessels-of-war of the same class as the old seventy-four, can penetrate their likes at say 2,000 to 2,500 yards range. The old ships fought always much within their effective range.

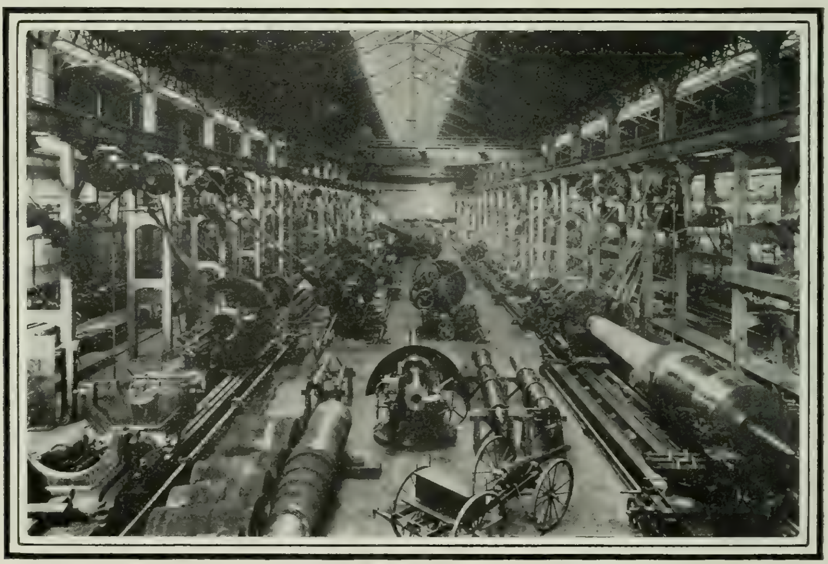
ONE END OF THE ELSWICK SHOP FOR GUNS FROM 6-INCH TO 3-INCH CALIBRE.



NILES GUN-BORING AND TURNING LATHES IN THE OBOUHOFF WORKS, ST. PETERSBURG.

THE MACHINE SHOPS OF THE ORDNANCE WORKS OF SCHNEIDER & CIE, LE CREUSOT.

and probably the modern ones will do the same. To accomplish anything without exhausting their supply of ammunition they will find that they must do so, because even when the sea is comparatively smooth there will be, in the excitement of battle, many misses. The battle-ship of old fought at about one-third of the effective range of



WORKSHOP FOR LARGE-BORE GUNS AT THE ORDNANCE FACTORIES OF SCHNEIDER & CIE, HAVRE, FRANCE.

TRAINLOAD OF GUNS FOR U. S. ARMY LEAVING BETHLEHEM STEEL WORKS DURING THE SPANISH-AMERICAN WAR.

her guns; at what range will the next great naval action be fought? Those at Yalu, Manila, and Santiago, not being between equally matched ships, hardly give us an answer to this all-important question.

Much has been done in the past twenty-five years to raise ordnance engineering to the rank of a science. Sarrau and Vieille have contributed their excellent works on interior ballistics, and Berthelot and others have investigated the chemistry of explosives, while Rankine, Virgile, and many later authorities have given us mathematical treatises on the strength of guns. The computation of the trajectory of projectiles in air has also been completely worked out. In short, guns and powder can now be made and results predicted in advance in ordnance as well as in any other branch of engineering science.

The strife between the attack and defense—between guns and armor—is always going on. Guns of one day are longer or heavier than those of another, or the reverse, and the weight of armor a ship carries shrinks up into small patches of great thickness, or spreads out over great areas, less well covered. Ordnance engineering follows and appreciates the history and actual condition of these movements, influences them to a considerable degree, and, with the materials and methods in hand, secures the best guns and protection possible.

# MINING INDUSTRY AND MINERAL RESOURCES OF BRITISH COLUMBIA.

*By Wm. M. Brewer.*

In a preceding article, published last month, Mr. Brewer reviewed the mineral deposits of the island regions of British Columbia. The present paper considers the mainland deposits, thus completing a general mineral survey of the province.—THE EDITORS.

IN a preceding article concerned chiefly with the island districts of British Columbia, I referred to some of the conditions which characterise portions of the mainland, especially north of the main line of the Canadian Pacific Railway in that portion known as the Gold Range. But except through a portion of the old Cariboo country, around Atlin and the Porcupine districts, comparatively little is known of the possibilities, geology, or mineral resources of that vast domain which constitutes northern British Columbia.

Along the coast line, where one would naturally look for the greatest developement because of its accessibility, mining operations have been shut down since 1899, when the Dorothy Morton (situated on Phillips Arm about 120 miles northwesterly from Vancouver) was producing an ore which yielded about $10.00 per ton in gold, treated by amalgamation, concentration, and the concentrates by the cyanide process. This district is receiving more attention during the present year, and work is being done on the Blue Bells, a gold-bearing quartz proposition located on Frederick Arm about 4 miles from the Dorothy Morton, also on the Young Australia, a similar proposition joining the Dorothy Morton. In fact, the most extensive developement work so far performed on the Coast has been done at this portion, where a wide zone of schistose rocks occurs containing bodies of quartz. This particular zone is, in my opinion, one of the most promising fields for the operator, because the quartz yields fair values in free gold (the surface sometimes containing as high as $80.00 per ton, but less at depth), it occurs in extensive bodies, can be mined at a very low cost, and the mineral claims are very easy of access from tide water. The prospecting so far done at deep levels has been confined almost entirely to cross cutting, and but very little drifting along the quartz ledges has been attempted.

Further up the coast, the only other mining districts where any exploitation for lode mines has been carried on are along the Skeena and Nass Rivers, where for the past two years operators have been at work developing bodies of sulphide ores. Near Port Essington on the Oxtail River, a tributary of the Skeena, a syndicate of Victoria men have been developing an extensive deposit of iron pyrites. From this shipments have been made to the Victoria Chemical Works, where the ore is used for the sulphur contents, and the cinder treated to recover the gold values, which have sometimes run as high as 4 ounces of gold to the ton of cinder. The sulphur content of the ore averages about 45 per cent.

Flanking on the northeast side the zone which carries the quartz bodies occurring in the vicinity of Phillips and Frederick Arms, already described, there occurs a zone carrying sulphide ores in which chalcopyrite carrying good copper values predominates, and the country rock is more granitic in character. This zone apparently extends from the southeast and may possibly bear some relationship to the zone of sulphide ores which occurs to the north of the city of Vancouver, and has been exploited to some extent on Theodosia Arm, Jarvis Inlet, and the head of Frederick Arm. At the last named location, considerably more work has been done than elsewhere. The British Columbia Exploring Syndicate have been operating steadily since 1899, and report a large body of ore in sight, but because of lack of transportation facilities to tide water no shipments have been made. However, the management purpose installing an aerial tramway in the future, providing after a more thorough exploitation sufficient ore can be blocked out to warrant the investment. Because of the topography of the country, it was deemed advisable on this property to run a long cross-cut tunnel to intersect the ledge at a deeper level than has been explored anywhere along this zone, and the future of the property depends largely on the results obtained from this work.

The topography of the entire coast line, and usually for some distance inland, is particularly favourable for tunnelling propositions; but past experience has shown that driving cross-cut tunnels, even when deep levels are gained, is a costly and often disappointing experiment in the formations which predominate along the coast, and on the

Pacific Islands especially. It is a practice which has nevertheless been very general amongst the pioneer operators, chiefly for the reason that it is very difficult to transport hoisting and pumping machinery to the altitudes at which most of the outcroppings occur. There is no doubt, though, but that in several cases sinking on the outcrop and following the ore bodies down would have resulted much more satisfactorily.

As The Engineering Magazine has recently published a brief sketch of the mineral resources north of the main line of the Canadian Pacific Railway,* I shall take up as briefly and comprehensively as possible the present conditions of the mining industry in the southern portion, where lode and dredge mining are the order of the day.

Dredge mining is confined to the Fraser and North Thompson Rivers. Several attempts in the past resulted in failures at various points along the Fraser River. Various causes were assigned for these failures, but none of them were attributed to lack of pay in the beds of these rivers. Faulty construction and bad management were the responsible agencies. There is no disputing the fact that the formation of the river bed of the Fraser was unfamiliar to most of the operators. The immense boulders, cemented gravel, and vertical dip of the schist, slates, and sedimentary rocks composing the formation, rendered it absolutely necessary that the machinery of the dredges should be very heavy and capable of withstanding immense strains. Therefore when some practical dredge miners from New Zealand took hold of the work after thoroughly familiarising themselves with the local conditions, their operations resulted satisfactorily.

Near Lytton on the Fraser River a bucket dredge has been in successful operation about a year. The plant is designed after the most modern New Zealand pattern, very heavy buckets being arranged with chain couplings. This chain of buckets revolves on heavy gearing, so that all the time a certain number of the buckets are travelling up from the river bed loaded, while others are travelling down, after dumping their contents into a revolving screen, and each one takes its turn to scrape the bed rock. By this means, boulders, cemented gravel, and a portion of the bed rock are raised. The boulders and gravel, after being thoroughly washed by a strong stream of water, are discharged from the screen into the river behind the dredge, while the finer material, carrying the gold in dust and nuggets, passes from the meshes in the revolving screen over riffled tables where most of the gold is retained, while the sand is washed into sluice boxes arranged in a line at right angles to the tables. Through these sluice boxes the tailings are washed out into the river, while any fine gold which may have escaped from the tables by passing over with the sand is saved.

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* See the article by H. Mortimer Lamb, The Engineering Magazine, July, 1900.

At present there is only this one dredge working along this portion of the Fraser River, but another is being worked on the North Thompson, a tributary of the Thompson, which itself empties into the Fraser.

The nearest point to the coast where there is any activity in lode mining is about four miles southwesterly from Kamloops, about 200 miles northeasterly from Vancouver, and at the confluence of the North Thompson and Thompson Rivers. Copper-gold, iron, and cinnabar ores are found in this vicinity, the latter occurring in a northwesterly direction from the town. Although exploited to some extent about 1898, yet since then the mine and retort have been idle. The most extensive developement work which has been done in this immediate vicinity is on the Iron Mask mineral claim, which has been exploited to a depth of about 500 feet. By cross cutting and drifting on the various levels it has been demonstrated that the main ore body has an average width of about 60 feet. The ore carries fair gold values, as well as copper. During the developement several car loads of ore have been shipped to the Trail and Granby smelters, but the English company which owned the property are contemplating the erection of their own smelter in the vicinity of the mine, provided further developement shows sufficient ore in sight to warrant the erection of a smelter of a large capacity.

A cursory examination of the various mineral claims in the neighbourhood shows that there are some unique features connected with the bodies of copper-bearing ore which have been discovered up to the present time. The surface outcroppings cover a zone some twelve or fifteen hundred feet in width, which can be easily traced from point to point for some three or four miles. The outcroppings are usually composed of a heavy bed of washed gravel cemented together and containing copper carbonates, appearing sometimes in crystals of considerable size, at others in smaller particles disseminated through the gravel, and at still other times showing merely stains of copper.

Although so far as known at present the copper-bearing zone is only local in its limits, yet by travelling southeasterly one passes through a country in which deposits of copper-bearing ore have been discovered at several points under very similar conditions to those surrounding the ore bodies in the vicinity of Kamloops. The belt or zone is of variable width, sometimes exceeding a mile, and the points where discoveries have been made are separated from each other usually by several miles. For instance, in the Nicola Valley near the village of Coutlee one finds several discoveries of copper-bearing ore bodies flanked on the northerly side by extensive coal fields; at Aspen Grove occurs another belt of copper-bearing ores and within a few miles a coal field extending from the Tulamene River near Otter Flat towards Granite Creek and the Similkameen River.

Whether a thoroughly systematic geological survey would demonstrate that there exists any relationship between these various discoveries of copper-bearing ore, is a question that can be solved only by such a survey. At a casual glance it would appear as though several isolated areas of copper-bearing ores occurred, but when a more careful study is made of the entire Province, the explorer finds reasons to believe that the mineral-bearing areas do not occur in a haphazard kind of way but follow certain lines of direction approximating to the lines of strike of the country rock, and that although in such zones there are undoubtedly very many barren spaces, yet if the prospector follows out the indicated line, he may yet find ore bodies in many portions which are barren so far as is known at present.

Travelling eastward along the main line of the Canadian Pacific Railway from Kamloops one passes through no metalliferous-mineral-producing areas of any note until the Columbia River is reached. At Revelstoke, where the railroad crosses the river, the traveller finds he is in the centre of a field rich with possibilities and one which merits the earnest attention of the prospector.

Although comparatively little attention has been paid to prospecting from this point, yet there have been found many mineral-bearing claims both to the northward and southward. Most of the prospects heretofore located in the former direction have been in the neighbourhood of the Big Bend of the Columbia River. Such comprise copper-gold bearing ores, some placer gold mines, and an occasional discovery of argentiferous galena. But comparatively little work has been done in this neighbourhood, owing principally to lack of capital and of good wagon roads into the various camps. Pack trails have been used, but the cost for taking in supplies over them is necessarily very high, and that reason alone is sufficient to retard developement work except in a camp where the ore is either free-milling gold or exceptionally high-grade silver or copper.

Travelling eastward along the main line of the Canadian Pacific to the Arrow Lakes, one really commences to enter the chief productive mining districts of the mainland, viz., the West Kootenay, which includes the Lardeau, Slocan, Rossland, and Nelson mining districts.

The Lardeau district, which is entered by steamboat along the northwest arm of Arrow Lake and by a short line of railroad penetrating the district, is the northernmost of these productive mining areas. It is also the most recently discovered—in fact, the first developement of the district commenced as late as 1899. From that time until last year, when the railway was completed, the progress was very slow owing to lack of transportation facilities except by crude trails. The mountain ranges reach a higher altitude than is generally the case, and form the watershed between the Columbia River on the west and the Kootenay on the east. The character of the ore is high-grade argentiferous galena and free-milling gold quartz.

It is difficult to connect the discoveries in this district with any other, but possibly a thoroughly systematic geological survey may determine some relationship between the Lardeau and the Slocan. The ores are quite similar in character, except that in the Slocan, to my knowledge, no gold-bearing quartz has ever been discovered. Now that transportation facilities have been afforded for shipping the ores from the Lardeau, that district ought to develope into as good a poor man's country as did the Slocan. The topography of the two districts is very similar, and because of this topography the miners in the Slocan have been enabled to prosecute their work by tunnelling, either drifting on the ledges or cross cutting and then drifting, thereby avoiding expensive plants for hoisting and pumping. The rich grade of ore in such mines as the Reco, Goodenough, Last Chance, Payne, Slocan Star, Ruth, and others has enabled the operators to haul to the railway sacked ore by means of raw-hiding down the mountains in the winter. With a lower-grade ore such a method of transportation would not have been possible. The same conditions as to grade exist in the Lardeau country; in fact, the ore from some of the Lardeau mines has proved to be a much higer grade than from many of the Slocan mines, which produced during 1901 25,493 tons of ore of gross value $1,865,752. Naturally, since the fall in price of silver and lead, progress in the Slocan has not been as phenomenal as it was from the discovery of the district in 1892 up to 1899; but owing to the fact that several of the mines adopted concentration for their extensive bodies of low-grade ore, the yearly output showed an increase in 1900 and 1901 over the two preceding years. While of course such a showing is very gratifying, yet it would have been more so had there been in addition to this a noticeable enlargement of the territory containing productive mines. The reasons I have given, however, are amply sufficient to account for lack of progress in that direction.

South and east from and adjoining the Slocan district, is situated the Nelson or Kootenay Lake. The northern portion of this district, around Kaslo and Ainsworth, produces ore of a character similar to that of the Slocan, and the first discoveries of this character of ore made in British Columbia were those in the mountains around Kaslo by prospectors who travelled up the Kootenay River from Bonner's Ferry south of the international boundary and prospected along the shores of the Kootenay Lake. The southern portion of the district, in the neighbourhood of Nelson, received its first impetus from the discovery of the Silver King mine, about four miles from the town, producing a gold-silver-copper ore for the reduction of which a local smelter was built in 1896. Until recently, when this mine was closed down, it furnished a considerable quantity of smelting ore, but at the present time the smelter is being run on custom work.

In addition to this character of ore, the Nelson district has received a great deal of merited attention because of the occurrences of free-milling gold ores some few miles from the town on the line of the Nelson and Fort Sheppard railway, a branch of the Great Northern. The Ymir mine is the most extensively developed and has been the most productive of all of these occurrences. It has paid several dividends to date. The underground workings have determined that the ore body maintains continuity to a depth of 1,000 feet. In fact, this is one of the big mines of the province, and if space permitted is deserving of an extended description.

To the southeast of and adjoining the Nelson district is situated the Trail, or, as it is better known, the Rossland. The Le Roi, War Eagle, Centre Star, Iron Mask, and Le Roi No. 2 properties have given this district a world-wide reputation. That these are big mines has been determined by the output and shipments of ore to the smelters; and their developement in future to be bigger mines still is only a question of the successful concentration of the immense bodies of low-grade ores, so that the cost for mining, concentration, freight, and treatment will be brought well within the yield. The Rossland district has had many serious obstacles to contend with since 1899:—First, the excessive prices paid for productive properties, excessive capitalisation, and lack of provision for sufficient working capital to enable the properties to earn dividends proportionate to their capitalisation; second, the labour troubles, which in the first place were directly attributable to the passage of the eight-hour law by the British Columbia Legislature, and demand by the miners for ten-hours pay for eight-hours work; third, the decrease in grade of the ore in the lower levels, which taken in connection with the fall of the price of copper was sufficiently serious to turn what had been a profit into a loss on the mining, shipment, and treatment of a very large tonnage of ore. But from the latest reports it appears that the Elmore method of concentration, in which oil is used instead of water, is going to prove a solution of the difficulty with which the management have at present to contend. The adoption of this process will mean to Rossland not only the circulation of a great deal of wealth during the construction of the plants, but also a renewal of that prosperity which promised to be permanent a few years back. It will probably mean the resumption of dividends by the Le Roi, War Eagle, and Centre Star mines, and in consequence a greatly increased demand for the stocks at something near their old-time values.

The character of ore which has heretofore been productive in the Rossland district is a pyrrhotite, carrying principally gold values with about 1.5 per cent. in copper; of this the mines receive a very fair proportion from the smelters, instead of the latter deducting 1.3 per cent. —the difference between the wet and dry assay. The Le Roi Company because of owning its own smelter, which is situated at Northport, Washington, a short distance across the line, is of course in a better position to handle a low grade of ore than are the War Eagle and Centre Star Companies, which have to ship their ore to the Trail or some other custom smelter.

From the report of the Minister of Mines for the year ending December 31, 1901, is taken the following information relative to the Le Roi Mine:

| | |
|---|---|
| Tons of ore shipped (dry) 1901 | 158,598 |
| Average number of men employed | 302 |
| Underground | 231 |
| Surface | 71 |

DEVELOPEMENT DURING SAME YEAR.

| | | |
|---|---|---|
| Shafting | 227 | feet |
| Driving | 1,517 | " |
| Raising | 487 | " |
| Cross cutting | 625 | " |
| Winzing | 43 | " |

The value of mining plant, machinery and buildings is $280,890.00."

In the same report appears the following extract from the report made by Mr. R. J. Frecheville, M. I. C. E., to the Directors of the Le Roi Mining Co. and dated Rossland, Dec. 24th, 1901:—

"Mine Workings.

"The mine is opened out by two incline shafts on the middle vein, called the old shaft and the combination shaft. The former, which is down to

> the 900-foot level, is situated about 200 feet west of the Centre Star boundary line, and the latter, which has reached the 1,050-level, is 360 feet further west on the strike of the vein, or nearly in the centre of the developed ore shutes. The old shaft has recently been straightened and partially re-timbered at a cost of about $5,500, but is not now used and most probably never will be again. This expenditure might well have been saved. The Combination Shaft is the working shaft of the mine. It is 275 feet long by 6 feet wide in the clear of timbers, and is divided into five compartments. At the 1,050-foot level the station has been cut, but the levels are not yet driven. The 900-foot level is the deepest level in the mine. This shaft has cost in round figures about $100,000. It is a fine piece of work, but is unnecessarily large. The ground proved to be ore-bearing extends from the Centre Star boundary line on the east to the Josie Dyke on the west, a distance of between 1,300 feet and 1,400 feet. At the 500-foot level the combined length of the pay chutes on the middle vein is about 745 feet. On the 600-foot, 700-foot, and 800-foot levels it is about 900 feet for each level. The width of the chutes varies from 6 feet up to 100 feet. On the 900-foot level, which is only partly opened, the pay chute has a length of 170 feet by a width of 24 feet. The general trend of the ore bodies appears to be to the west; thus at the 900-foot level no pay ore has been opened out east of the Combination Shaft. If the present chute now being opened out at this level extends uninterruptedly up to the Josie Dyke, its length cannot exceed 700 feet. This shortening of length is so far compensated by considerably greater average assay value. The western portion of the south vein has been opened by cross cuts from the middle vein at the 500-foot and 700-foot levels, showing a chute of ore about 140 feet long, with an average width of 18 feet. The ore is of lower grade than that of the middle vein."

In summing up, Mr. Frecheville estimates that there were in sight on the date of this report on both veins 604,840 tons of mine ore of an average assay of $10.36 per ton.

The following information relative to the War Eagle Mine is extracted from the report of the General Manager, Mr. E. B. Kirby, dated Jan. 18th, 1902:—

> "The closure of the War Eagle Mine by a general labour strike has restricted the mining of the past year to a period of about seven months. This further loss of time leaves us still short of decisive results from the great depth of vein made accessible by the rapid shaft sinking. The shaft, 1,499 feet deep on December 31, will reach the 11th-level point at 1,580 feet by the end of February, and sinking will then be suspended until decisive results are secured from the vein area then accessible.
>
> "The levels are as follows:

| | | |
|---|---|---|
| 6th level | 754 | feet in depth. |
| 7th " | 881 | " " " |
| 8th " | 1,057 | " " " |
| 9th " | 1,228 | " " " |
| 10th " | 1,387 | " " " |
| 11th " | 1,580 | " " " |

“The ore shipments for the year amount to 19,864 tons, averaging $15.64 smelter's gross assay value. The average contents were 0.633 oz. gold, 1.08 oz. silver and 2.1 per cent. of copper.

The ore shipments from the Rossland district during the year ending December 31, 1901, are given in the Minister of Mines report as:

| | | |
|---|---|---|
| Le Roi | 158,598 | tons |
| Le Roi No. 2 | 35,956 | " |
| Rossland Great Western Mines, Ltd. | 10,046 | " |
| Centre Star | 53,590 | " |
| War Eagle | 19,863 | " |
| Iron Mask | 4,224 | " |
| Velvet | 540 | " |
| Portland | 24 | " |
| I. X. L. | 188 | " |
| Spitzee | 172 | " |
| Evening Star | 73 | " |
| Homestake | 33 | " |
| Total | 283,307 | tons |
| Gross value | $4,621,299 | |

Travelling westward along the Columbia Western branch of the western extension of the Crow's Nest branch of the Canadian Pacific Railway from the Trail mining district, one enters the Boundary Creek district. Until the completion of this line in 1899 this district had made but little progress, but the following list of shipments copied from the Minister of Mines report for the year ending 1901, will show how phenomenal has been its growth since then:

| | 1900 | | 1901 | |
|---|---|---|---|---|
| Old Ironside and Knobhill Group | 64,531 | tons | 231,762 | tons |
| Mother Lode | 5,564 | " | 99,548 | " |
| B. C. | 19,618 | " | 47,517 | " |
| Golden Crown | 2,241 | " | —— | |
| City of Paris | 2,000 | " | —— | |
| Winnipeg | 1,076 | " | 977 | " |
| Snowshoe | 267 | " | 1,731 | " |
| Athelstan | 1,200 | " | 550 | " |
| Carmi | —— | | 885 | " |
| King Soloman | —— | | 850 | " |
| No. 7 | —— | | 665 | " |
| R. Bell | —— | | 480 | " |
| Sunset | —— | | 800 | " |
| Jewel | 160 | " | 325 | " |
| Brooklyn | 150 | " | —— | |
| Ruby | —— | | 85 | " |
| Sundry small shipments | 1,000 | " | 500 | " |
| | 97,837 | tons | 386,675 | tons |

The most noticeable features in the Boundary Creek district, considered in a general way, are:

First, the enormous extent of the surface outcroppings of magnetite carrying chalcopyrite disseminated through the iron ore.

Second, the character of the ore, which is not only self-fluxing but at times rather basic, so that about 5 per cent. of quartz ore can be smelted to advantage with the average ores of the district.

Third, The extremely low cost at which the average ore can be mined and smelted because of the extent of the bodies and character of the ore.

A geological survey of this district was made about two years ago by Mr. R. W. Brock, of the Dominion Geological Survey, who says in the concluding paragraphs of his report:

> "Some of the practical deductions from an examination of the ore deposits may be summarised as follows:
>
> "Ores may be found in any of the older rocks where the other conditions for mineralisation were favourable.
>
> Districts which show evidences of late disturbances, through vulcanism, manifested by intrusions of recent eruptives and heavy diking, are promising fields for prospecting.
>
> "Limestone contacts in such areas should in particular be carefully prospected.
>
> "Since, with the exception of certain deposits in Copper Camp, there is no zone of oxidation and secondary enrichment in the main deposits, while the general conditions remain unchanged, no loss of values is to be expected in depth.
>
> "On account of the irregular form which the ore bodies may possess, and the complex nature of the rock formations, a careful and detailed study of the surface of the ground in the neighbourhood of the mines would be of great practical assistance in the exploitation of the ore bodies. For the same reason developement work must always be kept well ahead of the actual mining. Cross-cutting must frequently be resorted to, to determine the actual limits of the deposit, and to prove the existence or non-existence of parallel ore chutes. The limits of mineralisation must be carefully proved, and similarly that ore can with certainty be reckoned on which has actually been blocked out. In this connection diamond drilling can be used with advantage. Careful magntic surveys would always be of great value in locating ore bodies under the covering of drift, and also for testing for ore in the mines themselves. Especially good results should be obtainable by this method in the magnetic type of deposits, but it should also prove successful in the pyrrhotitic deposits.
>
> "Where the ore occurs at a limestone contact the limestone wall may often be used for following the ore, it being kept in mind that the ore does not always follow strictly along the contact, and that the limestone may pinch out without causing the ore likewise to give out. The dikes in some cases may be used in the same way."

# THE LIGHTING OF RAILWAY TRAINS IN EUROPE.

*By H. Guérin.*

THE progress which has been made in recent years in the lighting of public streets and apartments has naturally had its influence upon the equipment of railway carriages, in which so much has been done of late in other respects to add to the comfort of the occupants. Formerly it was considered sufficient if enough light was provided to permit the traveller to find his way to his place in the compartment, but today the travelling public demands sufficient light to read or work without interruption. If, upon some rare occasion, on certain lines one meets an old-time carriage, he may even today find very rudimentary illuminating appliances, and thus be enabled to realise more fully the progress which has been made by means of the perfected appliances used in the luxurious modern vehicles. The progress in lighting can really be followed distinctly by a general inspection of existing vehicles, since it is impossible to effect a complete substitution at any time, improved methods replacing the older ones gradually as the carriages themselves are worn out and replaced in regular service. At the same time there will be observed a continual attempt to improve the more primitive lighting systems in the older carriages yet in service, so far as this can be done without injury to the structure.

The illumination of a railway carriage is really a complex question, involving the peculiar conditions which belong to its perambulating existence. One must take into account the instability of the air supply, due to the varying speed of the train, the action of the wind, etc., also the limitations of communication between the interior and exterior of the compartments, the necessity for providing for escape of the products of combustion, and for the rapid lighting of the burners. Provision must also be made for the reservoirs for the liquids often employed, and the reservoirs of the lamps must be so placed as to avoid the production of deep shadows in certain parts of the compartment. The transport of illuminating oils also involves a certain degree of danger from fire, especially in case of collisions or other disasters, this consideration especially demanding the use of simple and strong forms of construction. When the numerous conditions are considered it will be realised that many existing methods of illumination leave much to be desired, as we shall see in the following rapid study of the subject.

Lighting by Candles:—At the present time candles are very seldom used in railway trains in France, not only because of the insufficiency of the illuminating power, but also because of their limited duration and high cost. They are really used only as a temporary resource in emergencies, as we shall observe later on. In other parts of Europe, however, this cannot be said. In Russia, for example, candles are still generally employed on the lines of the interior, the use of petroleum having been attended with but limited success. Candles are also used altogether on the South-Eastern Railway of Prussia, but elsewhere the employment of this primitive means of illuminating is exceptional.

Lighting by Oil Lamps:—The early attempts to use oil employed lamps without chimneys, using flat wicks immersed in reservoirs of oil with variable or constant level. These lamps were inclosed in lanterns built in the roof of the compartments. This arrangement is still continued in many instances, although it involves the inconvenience of requiring the attendant to ascend to the top of the carriage. The feeble light and general smoky condition of these early lamps have led the various railway companies to make efforts to improve them, and ecpecially to effect a better combustion of the oil. The oil itself is required to be pure and free from adulterations and to be quite neutral; it should give a clear, smokeless flame, when burned in a "moderator" lamp, producing an intensity of one carcel (9½ candles) with a consumption of 42 grammes. Improved forms of construction have been devised, the aim of all being to increase the illuminating power by improved combustion, and at the same time to effect better distribution of the light.

On the Western Railway of France a flat-wick lamp without chimney has been adopted, consuming 25 to 30 grammes of oil per hour. This has been replaced on the Northern Railway of France by a larger lamp of similar construction, with the oil reservoir placed above. The reservoir is annular in form, communicating with the burner through two tubes. The annular space is entirely filled with oil, no air being permitted to remain, the burner being fed solely by capillary action. The space between the annular reservoir and the burner is occupied by a reflector; there is an opening in the centre communicating with a sheet-metal chimney forming a part of the lantern surmounting the lamp, which provides for the discharge of the products of combustion.

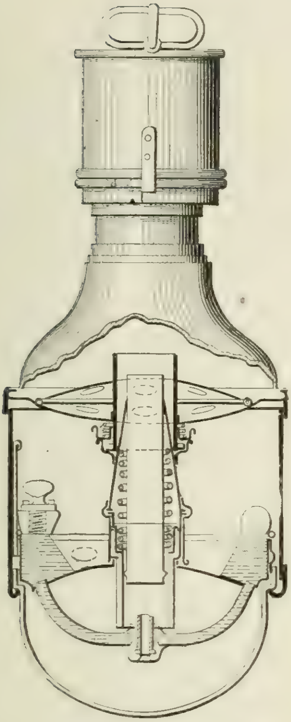

FIG. I. FAUCON LAMP.

The cap of the lantern is formed of several cylinders, pierced with holes, these serving to check the force of the wind produced by the motion of the train and prevent it from blowing out the flame. The whole lamp is enclosed in a glass cup, preventing all communication with the interior of the carriage, this cup also receiving any drops of oil which may be accidentally spilled. This lamp gives a strong light, but is liable to smoke, and possesses the disadvantage of being fixed to the carriage.

Experience, confirmed by numerous tests, shows that with flat-wick lamps there will always be an incomplete combustion and imperfect illumination. This has led various companies to adopt cylindrical burners. Thus the Eastern Railway of France has used the "*Faucon*" lamp with a cylindrical wick and central draught, consuming 20 grammes of oil per hour and operating for 13 consecutive hours without attention; the illuminating power is 5 to 6 candles, or in the latest forms, 8 candles, with a consumption of 35 grammes of oil. The general arrangement is shown in Figure 1. The annular oil reservoir is retained, but a cylindrical wick replaces the flat one, the holder being provided with a central opening to permit the air to reach the flame. The burner is arranged to hold a glass chimney extending up into the metal chimney of the lantern. This type is also used on the Paris-Lyons-Mediterranean Railway, and on the State Railway of France.

The Northern Railway of France also employs in its first-class carriages an oil lamp with cylindrical wick. This lamp, of which the arrangement is shown in Figure 2, gives a brilliant and agreeable light, but is rather delicate as regards care and manipulation. The general arrangement of the parts resembles the Faucon lamp; the intensity of the light is 0.7 carcel (about 6¾ candle power) and the consumption 32 grammes of oil per hour. The upper reservoir, constructed on the principle of Mariotte's vase, maintains a constant level of the oil. A glass chimney is provided, prolonged by one of sheet metal of conical form to increase the intensity of the draught. The body of the lantern is pierced with holes to permit the entrance of the air for combustion, while the upper cylindrical portion is made removable for convenience in cleaning. The principal objection to this lamp lies in the fact that each time it is attended to it must be entirely emptied and refilled with fresh clean oil; this, however, can be satisfactorily effected by means of a special form of suction oil pump. The silvered reflector is formed with especial reference to the distribution of the light over the interior of the compartment without the production of dense shadows from the feed pipes.

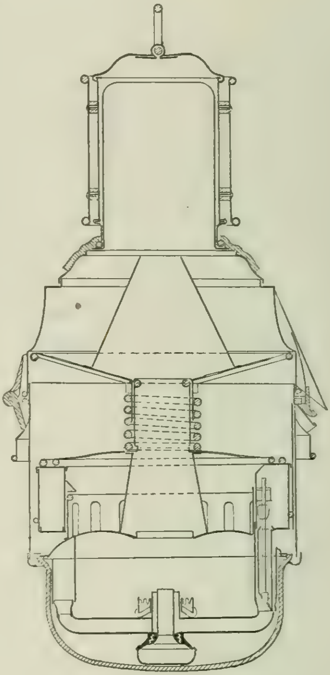

FIG. 2. OIL LAMP WITH CYLINDRICAL WICK.

The preparation of the cylindrical-wick lamp requires some time and proper facilities, and hence it is generally done in a special department. When ready for service, each lamp with its lantern is placed in a compartment of a special wagon, as shown in Figure 5. This wagon is drawn out to the platform and one attendant mounts upon the roof of the carriage while another passes the lamps up by means of a special hook. The fresh lamps are thus rapidly substituted for the empty ones, and these latter are drawn away in the wagon to the lamp room at the station. Various forms of lamps with cylindrical wicks are employed on the railways of other countries, one example being the Lafaurie & Potel lamp, shown in Figure 3, this also being used on the Western Railway of France. In this form the oil is maintained at a constant level in a vessel closed by a screw stopper, this latter being placed in the lower part to avoid possible entrance of air. The supply of air for the outside of the wick is produced by the draught of a metallic chimney supported by the reflector. The air for the interior of the flame is delivered through a lateral tube, parallel to the oil-feed tube, both draughts delivering up into the hood of the lantern; the glass chimney of the previous forms of lamp is thus omitted. This lamp gives a steady white flame with a consumption of 25 to 30 grammes of oil per hour and a duration of 16 hours.

In Austria, Hungary, and Roumania the railways use oil lamps with cylindrical wicks and glass chimneys. In Alsace-Lorraine Argand lamps are used, and in Baden single-burner lamps are employed. These latter lamps are arranged to be regulated by a rack and pinion, while the Lafaurie & Potel lamps, as well as the Faucon, and the type of the Northern Railway of France, have no means of regulation, the height of the flame being determined by the fixed height of the wick when the lamp is placed in position.

The number of lamps used to a carriage is variable. In France it is customary to use as many lamps as there are compartments. Some carriages are provided with but one lamp to two compartments. On the Kaiser Ferdinands Nordbahn, in Austria, in the third-class carriages, there are but one or two lamps used for three compartments.

Advantages and Disadvantages of Oil Lamps:—The advantages of oil lamps may be summed up as follows:—They produce a clear, steady light, free from serious danger of fire or explosions; they are not liable to general interruption, owing to their independence of one another, in contrast to electricity or gas; the apparatus is light, and the first cost moderate.

The disadvantages may be likewise enumerated:—Their action is liable to interruption in cold weather, requiring the reservoirs to be warmed; this may be avoided by the addition of petrole to the oil, but this again renders the lamps liable to smoke, besides conducing to explosions and fires. If the lamps are not well cared for the entrance of air is apt to cause irregular action, besides which the wicks become charred; hence a fair degree of skill is necessary for attendance. A certain amount of expense is also incurred in the breakage of glass chimneys and cups, so that when these points are taken into account it will be seen that this system of lighting is not very economical.

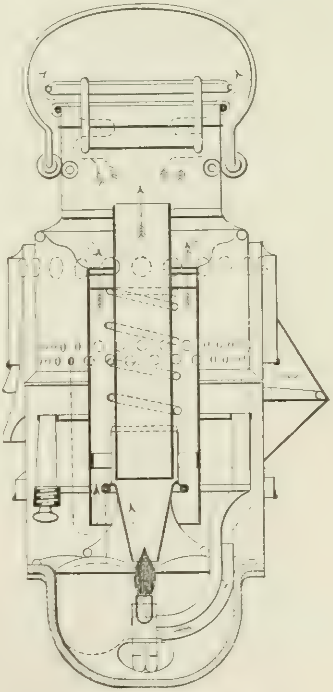
FIG. 3. OIL LAMP. LAFAURIE & POTEL SYSTEM.

Lighting with Mineral Oils:—Experiments in the use of petroleum for

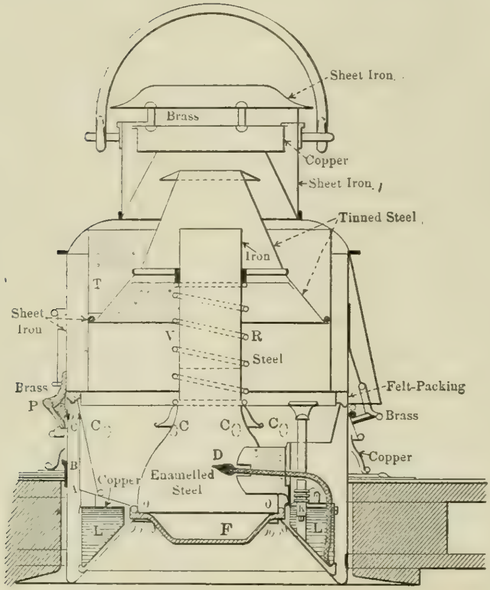

FIG. 4. MINERAL OIL LAMP, SHALLIS & MOURAS SYSTEM.

lighting have been made by the Northern and Western Railways of France, and while these have given interesting results the use has been discontinued as being too costly and dangerous. The Orléans Railway alone continues to use this system for first-class carriages, employing the Shallis and Mouras lamp, Figure 4. This apparatus may be divided into two portions, the lantern and the lamp properly so-called. The external appearance differs but slightly from the oil lamps already described. The external air enters the lantern through small holes in the lower part of the body in such a manner as to circulate about the oil reservoir. The upper cylindrical body of the lantern is also pierced with holes permitting the entrance of air to aid in the combustion. The lamp itself consists of a reservoir L, for the mineral oil, a double envelope, and a combustion chamber, D. The reservoir, made of tinned steel, contains about ½ litre, and is made without any seams below the level of the oil. The double envelope which separates the combustion chamber from the reservoir forms the reflector, E, shaped like a truncated cone to which is attached a cup-shaped partition. The rim of the base of the upper portion is provided with a packing of felt fitting against the top of the double envelope of the lamp, thus effectually preventing any communication between the upper part of the lantern and the portion containing the oil reservoir. When the lamp is lighted the air within the carriage is drawn through the openings in the conical reflector, circulates in the double envelope heated by the flame of the lamp, and escapes through the openings in the lower portion of the lantern. This circulation is intended to cool the reservoir containing the oil. The combustion chamber is closed by a bell of enamelled steel placed above a glass cup, F, and supporting the lower part of a spring chimney holder. The air required to maintain combustion is admitted through holes in the lower part of the bell, and is heated by contact with the envelopes of the lantern. The burner, G, is soldered hermetically to the double envelope, and is connected at its extremity with a tube admitting fresh air. The wick is regulated by a thumb button or by a removable key. The arrangement of the parts is such that the oil may be spilled without possibility of its ignition; the reservoir communicates with the external air by means of tubes, so that if the lamp is overturned in case of accident, the oil can escape without coming in contact with the flame. The intensity of this lamp is 1½ carcels (about 14 candle power) and its duration is from 12 to 14 hours. The density of the oil employed is 0.826 at 16° C., and it ignites at a temperature of 126° C.

This system of lighting has been used in various countries. In Bavaria and in Würtemburg various forms are used, with flat and with cylindrical burners. On the Hungarian railways the ordinary ceiling lamp is used in a modified form, with flat horizontal burners. The system, however, is far from being generally used. This is due to the great danger which attaches to the use of petroleum, notwithstanding the precautions which may be taken, since these may be rendered ineffective by the neglect of the attendants.

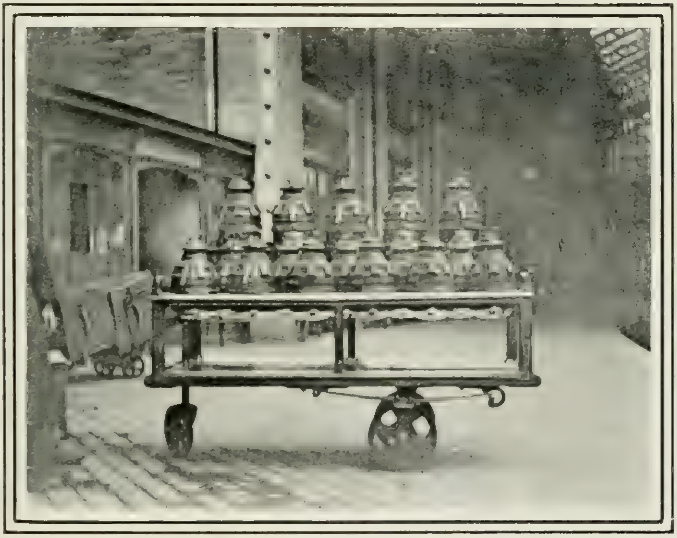

FIG. 5. CAR FOR TRANSFERRING OIL LAMPS, NORTHERN RAILWAY OF FRANCE.

Lighting with Oil Gas or Enriched Gas:—The first attempts to use gas for train lighting were made with compressed coal gas. Experience showed that the compression caused the gas to lose about one-third of its illuminating power. It was therefore sought to carburet the ordinary coal gas to enrich it. For this purpose the Western Railway of France has used a special lamp, Figure 6, containing a brass reservoir filled with fragments of of naphthaline. A small tube passes from this reservoir into the chimney of the lamp, where it is heated by the gases of combustion. The naphthaline in this tube becomes vapourised, while that in the reservoir is reduced to a liquid condition, and passes in turn to the vapourising tube. The gas, passing through an adjoining tube, mixes with the vapour of naphthaline, and is consumed in a goose-neck burner. This system, however, is liable to interruptions by the choking of the burner with naphthaline, and it has not been found satisfactory in practice. A more successful scheme has been to use the compressed air from the Westinghouse brake reservoirs, carburetted with gasoline.

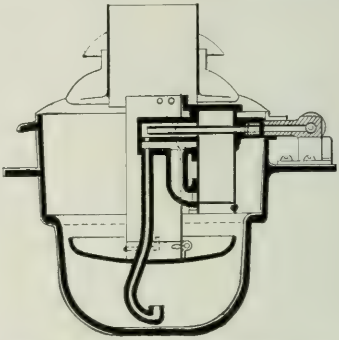

FIG. 6. LAMP FOR CARBURETTED GAS.

The most general method, however, is the use of compressed oil gas. This gas is either carried in special tank cars attached to each train, or else in smaller reservoirs attached to each carriage. The first method has been adopted in Belgium and in France; it is more economical than the second, but it involves the necessity of connecting the gas tank with a piping system extending through the entire length of the train, this involving a liability to serious leaks. Since 1881 the Western Railway of France has adopted the plan of placing separate reservoirs under the various carriages. The Paris-Lyons-Mediterranean Company also uses separate reservoirs, but places them on the tops of the carriages (Figure 7). Oil gas is produced by the distillation of bituminous schists, petroleum residues, and heavy mineral oils. Its illuminating power is 3.5 to 4 times that of ordinary coal gas. Thus a light of 6 candle power is obtained by an hourly consumption of 22 litres of gas, compressed to 10 kilogrammes per square centimetre, and released under a pressure of 10 millimetres of water.

This system includes an arrangement of piping under the platforms at the terminal stations, these connecting with storage reservoirs at the compressing stations, and enabling the reservoirs under the carriages to be charged promptly. Each carriage is provided with one

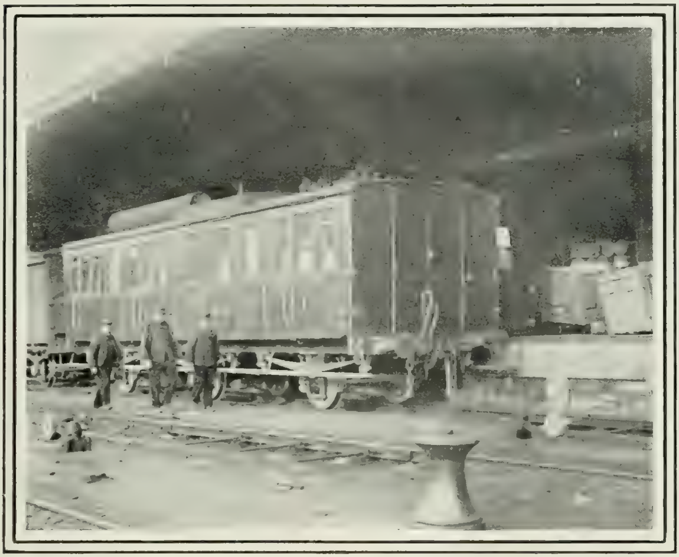

FIG. 7. CARRIAGE ON THE PARIS-LYONS-MEDITERRANEAN RAILWAY WITH GAS RESERVOIR ON THE ROOF.

or more tanks, holding sufficient gas to insure illumination for 16 hours at full brilliancy, the quantity of gas in the tanks being indicated by pressure gauges. The normal pressure is maintained at the burners by means of automatic regulators. The lamp is provided with a reflector of enamelled iron, placed above the burner, there being an opening fitted with a chimney for the escape of the products of combustion. The burner itself is separated from the interior of the compartment by a glass cup, similar to that used for oil lamps. In common with any system of gas lighting, the burners may be lighted in all or any of the compartments, or they may be controlled from one point only for the entire carriage. The usual practice is to have the lights controlled by the conductor, by means of a special key. They may also be provided with keys in each compartment, by which the travellers themselves may extinguish the light, or the gas may be turned off automatically by the closing of the screen provided to cover the lamp. This latter method is of interest, since by its use an economy of gas of 25 per cent. may be secured. In France the cost of a cubic metre of gas, including interest and depreciation on plant, is from 0.50 to 0.80 franc; in Belgium it is only 0.37 franc, and in Germany it is 0.57 franc.

Train lighting by oil gas has been used with success in Alsace-Lorraine, in Bavaria, in Austria, in Holland, in Switzerland, and in Belgium. It has been introduced gradually, but none of the railways which have introduced it seems disposed to abandon it. Its advantages appear in its cleanliness, the uniformity of the light, and the small amount of attention required. At the same time its use involves a certain degree of danger from explosions, and the cost of the installation, including the equipment of trains, stations, and apparatus, is considerable.

Lighting by Acetylene:—The lighting of railway trains by oil gas has been notably improved by the admixture with the gas of a certain proportion of acetylene. This idea was first employed on the Prussian State Railways, where it was found that the mixed gases gave a far superior light to that of the oil gas alone. In France this system has been taken up by the Paris-Lyons-Mediterranean Railway, and a generating plant is being installed adjoining that already in use for the production of oil gas. This station includes a storage department for the calcium carbide, which is kept in metal casks, handled by a swinging crane; also a second building in which the gas is generated. The generator is of the Pintsch system, in which the carbide is dropped into a large volume of water. The apparatus consists of a cylindrical vessel of galvanised iron filled to about three-quarters of its height with water, the top being closed and carrying a cast-iron chest containing the mechanism for feeding the carbide. This chest contains two compartments, each holding about 2 kilogrammes of carbide, and arranged in such a manner that either of them may be placed in communication with the main cylinder without permitting the escape of gas. The acetylene gas, disengaged by the contact of the carbide with the water, is led off through a lateral pipe connecting with the mains. The lime produced by the decomposition of the carbide is received upon an iron grating which can be tipped from time to time, and the residue removed through an opening at the bottom. The water level is regulated by a siphon, this also forming a safety valve. The ammoniacal water, impregnated with lime, is regularly removed by means of a Worthington pump. The gas is washed and purified from the ammonia and moisture which it contains by means of chloride of calcium. This apparatus has a capacity of 500 cubic metres of acetylene in 24 hours. The oil gas and the acetylene are passed though respective meters, these being connected by chain gear, the sprocket wheels being arranged so that the mixture of the gases is made in the ratio of 3 of oil to 1 of acetylene.

The mixed gas is supplied to the carriages in the proportion of 1,500 cubic metres of oil gas to 500 cubic metres of acetylene. The illuminating power is maintained at 12 candle power with a consumption of 25 litres of gas per hour. While good results have been obtained by the use of acetylene, it has as yet not been given a sufficient trial to determine its entire availability for train lighting.

Lighting by Electricity:—The electric lighting of railway carriages has been effected in three different manners:

1. By a dynamo driven by an engine receiving its steam from the boiler of the locomotive.
2. By a dynamo driven from the axle of the carriage, and operating in connection with a storage battery.
3. By accumulators charged at the terminal stations.

In the first system the dynamo and its engine are placed on the tender of the locomotive, the steam supply being regulated by a valve in the control of the engineer. This plan, which has been tried in England, has the inconvenience of depriving the carriages of light when the locomotive is disconnected from the train. Every time the engine is changed the illumination of the train is interrupted.

In the second system each carriage carries its own dynamo, driven by means of a belt from one of the axles, this charging a storage battery. This requires the introduction of mechanism to render the direction of the current independent of the direction of the motion of the train, and also to prevent the connection of the dynamo to the battery until the velocity of the motion renders the pressure of the current equal to the tension at the terminals of the battery. The intensity of the current generated by the dynamo assures the maintenance of a supply for the lamps, and the charge of the battery remains nearly uniform, whatever the speed of the train, by reason of the slipping of the belt when the resistance increases. A uniform tension is maintained upon the belt by the weight of the dynamo, partly relieved by a counterbalance. This arrangement, known as the Stone system, has been used in England, and also in the carriages of the Compagnie des Wagons Lits, and on the Paris-Lyons-Mediterranean.

The Western, Eastern, and Central Railways of France, and also the State Railway, have used the Vicarino system, the dynamo being driven from the axle by a friction gear, and operated in connection with a storage battery and make-and-break switch. The dynamo is arranged with a compound winding which provides a uniform voltage regardless of the speed of the train. When the speed attains 600 turns per minute the switch throws the current from the dynamo into the storage battery. The pressure employed is 30 volts, and the power absorbed by the dynamo is about 1½ horse power, the lamps being of 8 candle power.

In another system, used by the Paris-Lyons-Mediterranean Railway, the dynamo is also driven by belt connection with the axle of the carriage. A storage battery maintains the illumination of the lamps when the speed falls. If, on the contrary, the speed is increased, the switch throws the two sources of electricity in parallel. The intensity of the main current is maintained constant by means of a small motor operated by the excess energy of the dynamo, this creating a resistance which increases with the velocity. An automatic reverser renders the direction of the current constant, independently of the direction of movement of the carriage.

The third system has been employed by the Northern Railway of France, using accumulators contained in cases attached to the framework of the carriages. Each carriage is provided with four cases of accumulators. Hinged doors permit access to the batteries from without, openings in the sides of the cases permitting the escape of the gas. The batteries consist of elements contained in ebonite cells, placed in pairs in lead-lined iron baskets, insulated on glass plates, four of these pairs being in each case. Each element is composed of six positive and seven negative plates, the current being taken off by metallic spring clamps. The connections are made automatically by cables carrying metallic tongues at the ends inserted between the spring clamps. There are 60 elements to a carriage, arranged in two batteries of 30 elements each, there being 28 in regular service and 2 held in reserve. The two batteries are connected in parallel, both in charging and discharging. The plates weigh 1,100 grammes, or 14 kilogrammes per element; their minimum capacity is 10 ampere-hours per kilogramme of active material. The minimum capacity of one battery is therefore $14 \times 10 = 140$ ampere hours. In the interior of each carriage the switches are placed, these being arranged to give three connections, placing 28, 29, or 30 elements in the circuit (Figure 8), each switch being conected to one battery of 30 elements. After passing a safety fuse the current is divided into two circuits, Nos. 1 and 2, controlled by two switches placed in the corridor of the carriage. There are two lamps in each compartment, one fed by circuit No. 1, and one by circuit No. 2. The same arrangement is followed for the lamps in the corridor, one half being independent of the other half. The lamps are generally run at a pressure of 55 volts, with an illuminating power of 6 candles. These lamps are placed in the ceilings of the corridors and platforms, while in the compartments they are attached to the extremities of curved arms. The ends of the lamp bulbs in the compartments are obscured, to prevent the light from inconveniencing the occupants of the opposite seats. The arrangement of the wiring is shown in Figure 9, the wires being conveniently placed in channels behind the mouldings. The accumulators, of the Laurent-Lély type, are charged in the cases, before the departure of the train, by means of conductors arranged on the platform and connected to the electrical station. Here the alternating current originally generated at a pressure of 6,000 volts is transformed to a continuous current of 300 volts by means of the converters and transformers shown in Figure 10.

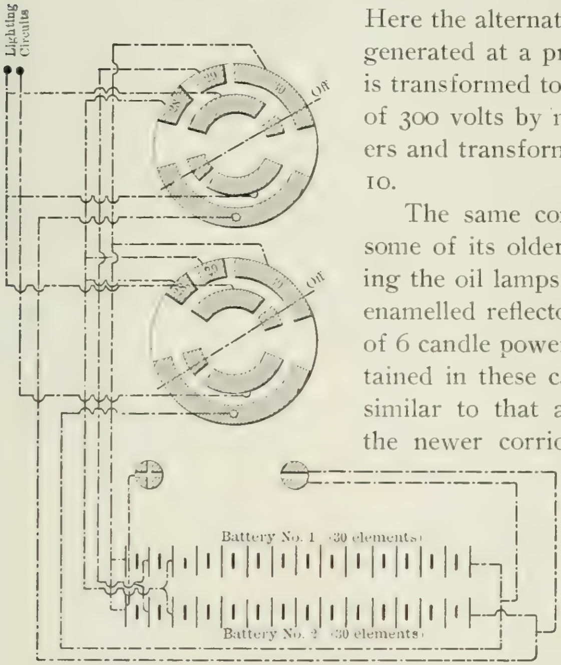

FIG. 8. WIRING SYSTEM, USING ACCUMULATORS.

The same company has improved some of its older carriages by replacing the oil lamps with lanterns having enamelled reflectors and electric lamps of 6 candle power. The current is obtained in these carriages in a manner similar to that already described for the newer corridor carriages, except that the storage batteries contain but sixteen elements in place of thirty.

Another system of train lighting by electricity, similar to that used in France, is found on the Jura-Simplon Railway, in Switzerland. The accumulators employed are of the Huber system, arranged in batteries of nine elements arranged in series. The plates are composed of non-oxidisable gratings of an alloy of lead and antimony, the cells of the positive plates being filled with minium and those of the negative plates with litharge. The electromotive force of a single element is 2 volts, or 18

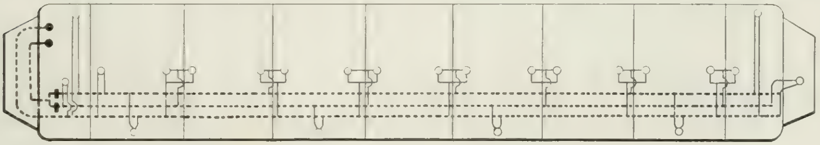

FIG. 9. CAR WIRING, NORTHERN RAILWAY OF FRANCE.

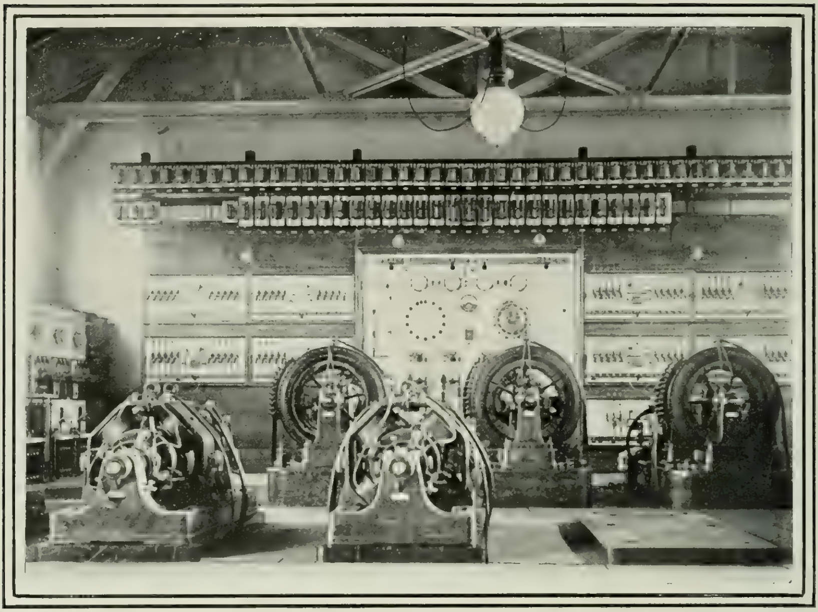

FIG. 10. TRANSFORMING STATION FOR ELECTRIC TRAIN-LIGHTING SERVICE, CHEMIN DE FER DU NORD.

volts for the series, the capacity being 120 ampere hours. The distinguishing feature of the system is found in the method of charging the batteries. On the Jura-Simplon Railway there are a number of stations at which accumulators are brought to the platform and substituted for those which have become exhausted on the trains. All the exhausted batteries are placed on a truck and taken to the distributing car. This car is devoted entirely to delivering charged batteries to the various stations and returning the exhausted ones. The charging is effected at a central station by a dynamo operated by a Thury motor of 35 horse power, itself driven by a current of 300 volts taken from the supply of the town. The accumulators are charged in series of five batteries, the initial tension being 90 volts, rising towards the close of the operation to 112 volts. The normal charging current is 18 amperes.

In Switzerland the cost of electric lighting is very moderate, owing to the favourable conditions for the production of electricity. Boilers and engines are entirely dispensed with, the energy being supplied altogether from the mountain streams, and the cost of current is only about 0.08 franc per kilowatt-hour.

# MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

*By Charles U. Carpenter.*

## VIII.—THE FINDING AND RECORDING OF COSTS.

**In the following paper Mr. Carpenter concludes his series, begun in February, 1902, and interrupted last month only by the author's serious illness. His first and second articles dealt with factory organization in its general principles and concrete examples, the third with departmentalization and systematization of the works, the fourth and fifth with the stock department, the sixth with machining processes and tool equipment, and the seventh with piece work and the fixing of prices. The whole series forms a consistent exhibition of a policy of management which has proved wonderfully successful in actual practice.—The Editors.**

MODERN commercialism not only demands the finest machinery and the most capable men working at the highest possible pitch, but also renders it imperative that all component parts be knit together by modern methods of organization, and that product, processes, departments, and men be checked up and their efficiency gauged by the most thorough methods of accounting and system.

How often has it occurred that a firm, prosperous in the early days of its existence, failed utterly after it had grown to such size as to make it impossible for the heads to retain that "personal touch" with details. The need of something to take the place of this personal touch is imperative and increases as the concern grows larger. The modern factory manager or superintendent must retain that vital touch with the internal working of his organization in this day of close competition, small profits, and intense activity of production. And yet, how many managers can distinguish the inefficient parts from the strong portions, and assign unerringly the cause for such inefficiency, thus being enabled to throw all of their power, knowledge, and experience toward the strengthening of such weak points? Can they state positively whether or not each department is being operated as economically or as efficiently as it should be? Can they detect immediately any increase in expense or deterioration in working efficiency in any of these departments? Are the costs calculated upon a correct basis, and are they compiled in such a manner as to show in detail any increases and, as well, render it possible to make intelligent examinations and comparisons with a view to the effecting of economies? In short, can the managers feel and judge of the pulse of their organization? Are they in such control of their mighty engine of production that they can detect, correct, and improve its weakest points and keep the entire machine keyed up to its highest pitch of efficient productiveness?

A flexible homogeneous system of factory accounting must be devised in such a manner as not only to show the costs of the product, but also to give unerring indications of the exact working conditions and efficiency of all departments in factory and office. The factory manager must have some means whereby he can check large unnecessary expenditures or heavy losses. He should be able to detect any increases in cost above normal, or any unnecessary investments in stock for manufacture. He should know not only the details of all gains and losses on the various products, but also the state of working efficiency of every department in the organization. This article will deal with a few of the important features of this subject. Owing to the fact that most of the data desired can be secured from properly devised cost records, consideration will first be given to the subject of "costs."

The necessity for accurate cost systems has been brought out so clearly in this Magazine by A. Hamilton Church, J. Slater Lewis, Henry Roland, Hugo Diemer, H. L. Arnold, J. N. Gunn, and others that it is unnecessary to dwell upon this feature of the question.*

Where does Profit End and Loss Begin?—The all-important question for every manager to ask himself is "Do I know positively at what figure my profit ends and my loss begins on each one of my products?" The commercial success of a business often depends upon the answer, and that answer is found in the solution of the problems of cost accounting, which may be thus classified:—

I.—The collection of data for the compilation of prime costs, *i. e.*, labor and material.

(a) The devising of forms, cards, tickets, etc., by means of which the data can be collected.

(b) The institution of methods for securing these data from the shop and of enforcing accuracy.

(c) Consideration of the various uses to be made of these data—"Workman's Time and Earnings Record," "Job Time and Wage Classifications," "Efficiency Reports," etc.

(d) Balancing of expenditures for labor and material with cost records.

II.—The collection and proper distribution of those items other than labor and material which cannot be charged directly against the jobs, but which should be charged against factory production, *e. g.*, general factory and departmental supervision, clerks, expense of non-productive departments, interest on investment, etc. These may be termed the Factory General Charges.

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* See The Engineering Magazine, Oct., '97—Jan., '98; Apr.—Nov., '98; Oct., '99—May, '00; June—Nov., '00; Jan., '01; July—Nov., '01.

III.—The collection and proper distribution of those items coming directly under the commercial end of the business, *e. g.*, salaries of officers, selling, advertising, legal, patents, etc. These may be termed the Commercial General Charges.

IV.—The collection and apportionment of these several charges unto the proper ledger accounts.

In view of the former articles appearing in this Magazine it is unnecessary to present any comprehensive discussion upon the question of costs. The most difficult problem to solve is the method of distributing the general charges. A system involving simple processes may, when carefully worked out, prove satisfactory provided the products and manufacturing processes are of a simple character, and the cost of production and necessary investments for machinery, etc., for these products do not differ largely. The case is entirely different where there is a large difference in the proportional expenditures for supervision, machinery, floor space, advertising, selling, etc. Certain it is that this difference must be considered when the system is devised.

Mr. Church's New Machine Rate.—Mr. Hamilton Church has presented a full and able discussion upon the defects of the ordinary "percentage-on-wages," "hourly-burden" and old "machine-rate" plans.* He proposes one of the most thorough and exact systems of distribution yet presented. His inclusion of the general charges in the "machine rate" and the further distribution of his "supplementary rate" disposes of this question with precision. His supplementary rate provides a valuable index of the working efficiency of machinery. It will be noted that this plan of distribution can be worked very simply into the plan of collecting cost data presented here.

Departmental Charges.—Whatever general plan of distribution be adopted, the general factory charges should be divided into departmental charges as far as possible. Each department is thus charged with its proportionate share of expense of general and departmental supervision, interest on investment, floor space, heat, power, light, etc. This total is then distributed over the work done in that department. In cases where there is a line of demarcation between the different products and the machinery, floor space, and power necessary for their production, it is possible to divide these departmental charges further so that each type of product will bear a part of each departmental charge, in proportion to the expense for machinery, floor space, power, etc., for which it is responsible.

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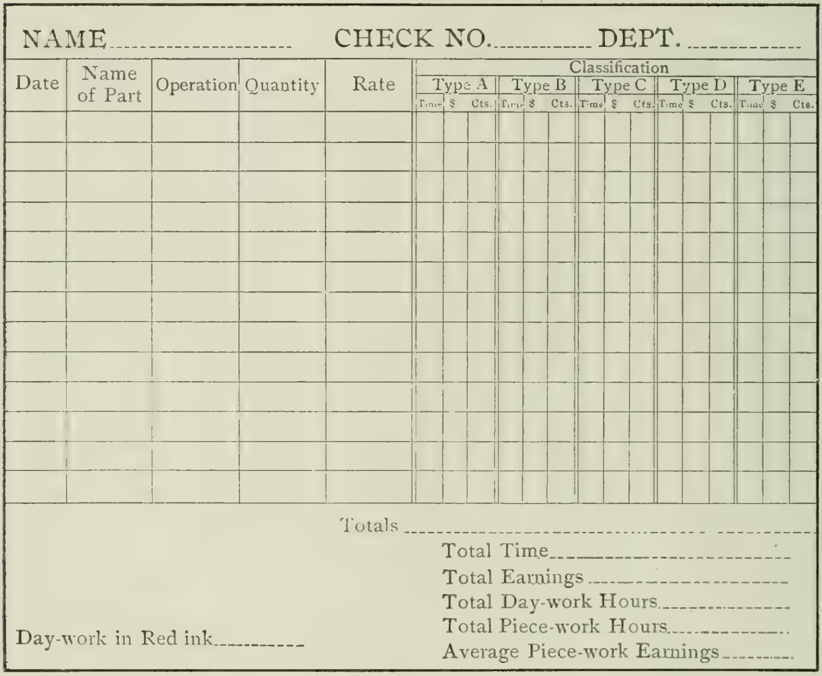
* See THE ENGINEERING MAGAZINE, July—November, 1901.

Collection of Cost Data.—The system presented for the collection of prime-cost data is but one of many effective ones. This, however, presents some distinctive features which prove to be of great value in many directions distinct from the cost system.



NAME.................... CHECK NO.............. DEPT. ..............

| Date | Name of Part | Operation | Quantity | Rate | Classification | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Type A | | | Type B | | | Type C | | | Type D | | | Type E | | |
| | | | | | Time | $ | Cts. | Time | $ | Cts. | Time | $ | Cts. | Time | $ | Cts. | Time | $ | Cts. |

Totals ..............................

Total Time..............................

Total Earnings..............................

Total Day-work Hours..............................

Total Piece-work Hours..............................

Average Piece-work Earnings..........

Day-work in Red ink..........

DAY-WORK AND PIECE-WORK RECORD CARD.

The ordinary system involves the use of time tickets and the entering of the data thereon, together with the material costs, in prime-cost books or cards. All material and labor entries go under the proper order numbers. Total or detailed costs of any order can be thus secured. The time tickets shown here are of ordinary form. The stock-tracing and cost cards are distinctive, and take the place of the prime-cost books or cards. In addition they fulfill other very valuable functions. All necessary data for compilation of prime costs and other records are secured from these time tickets and stock-tracing and cost cards.

Time Ticket.—A time ticket should contain all order, job, and machine numbers, names of department, foreman, workman, inspector, and stock tracer; number of parts finished by workman and number accepted by inspector; piece price or day-work rate, total time consumed, and total earnings. These tickets should be in duplicate.

Course that time tickets should take:—

1.—Made out and signed by workman.

2.—Signed by foreman.

3.—Sent to stock tracer, who enters up data upon corresponding stock-tracing and cost card and OK's ticket. This prevents duplication of tickets and makes it possible for these cards to serve as both cost and stock-tracing records.

4.—Turned over to inspector, who OK's ticket for accuracy of record, workmanship and amount.

5.—Original sent to cost clerk and duplicate to original workman.

Stock-Tracing and Cost Cards.—These cards should contain works and job-order numbers, name or number of part to be manufactured, kind, amount, and cost of raw material delivered, box numbers, and date work should be completed. The headings of the several columns show clearly the nature of the data required, including complete detailed cost, time, losses and machine number records, etc. The manner in which these data are secured has been explained in article on stock tracing.* Most of them are secured from the time ticket. Each part or number of similar parts necessary for each order should have its own card. All cards for parts belonging to one order should be kept together on the file.

Completion of Order.—As soon as the parts are finished and delivered as "finished stock," the cards for these parts, after being OK'd by stock tracer and stock keeper, are sent to the cost clerk.

The Requisition (see article on "Stock"*).—As all requisitions for stock necessary, for instance in assembling, must bear the proper order number and are sent direct to the cost clerk after being OK'd by stock clerk, they, together with the stock-tracing and cost cards bearing the same order number form a complete record of the material and labor costs of any order. Thus complete or partial costs can be secured at any time. These cards furnish also a series of records for analyses for estimating on new work; a perfect stock-tracing and time record; a complete history of all delays and losses; an effective bar to cheating; and a full and accurate inventory of all stock in course of manufacture. If it is desirable to extend all costs, the data on the cards and requisitions can easily be extended and results compiled upon special cards.

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* The Engineering Magazine, May and June, 1902.

These cards will contain the totals of materials and labor contained on each stock-tracing and cost card and requisition and, finally, the totals of all of these items.

Apportionment of Factory and Commercial General Charges.—This subject has already received such thorough treatment by previous writers for this Magazine that no further elaboration is needed.

Workman's Time and Earnings Card.—In the article on systems of pay was described the manner in which the time tickets, after being turned over to the cost clerk, are first assorted according to workman's name. The data thereon are transferred to the workman's time and earnings card. This card is so arranged as to provide a classification of time and earnings according to the type of product worked upon, the day-work time and earnings being entered in red ink, so as to differentiate them from the piece-work time and earnings. Each man's time must be checked against his time shown by the time clock or time book. Provision is made for totals of day-work and piece-work time and earnings, and the percentage of piece work to total time. These cards should be grouped by departments. From these cards we secure: 1, Total factory and departmental pay-roll; 2, total hours worked; 3, total time and earnings on each type of machine; 4, piece-work and day-work hours and earnings, and the percentage that the piece-work hours and earnings bear to the totals; 5, average rate per hour, piece-work and day-work. All these data are departmental.

Name Part________________Standard Time for Job________________________

Job No.____________________Operation______________Department______________

| Date | Name of Workman | No. parts Finished | P.W. Price or Day Rate | Time | | Earnings | | | Indicate clearly any variations from Standard Time and send to Supt. at once |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | Per part | Total | Per part | Area per hour | |
| | | | | | | | | | |
| N.B. Al | l Day Work | records to be in | red ink | | | | | | |

JOB-PRICE AND EARNINGS RECORD.

Job-Time and Earnings Card.—The workman's time ticket should next be classified by jobs and entries made as shown. An examination of this record renders its importance clear. The entries thereon will prove very instructive. It serves as the medium whereby any increase in labor costs on any job is immediately noted. I have already treated of the advisability of settling by calculation, investigation, or careful trial, the actual time in which each job could and should be done by the workmen.* This "standard time" per piece or per one hundred pieces should be put upon this job card. The entries should be kept up to date, and when any serious variation from standard time appears the cards should be sent to the superintendent for investigation. This should invariably be searching and thorough. Both foremen and workmen should understand that they will always be called to account for any serious variations from this standard time. If a workman's record shows badly in this particular, he should be dropped. This is a most effective method of comparing the capabilities of the workmen and of singling out the ones who should be discharged. Any tactics in the line of favoring an inefficient workman will fail before such a method. In many cases it will be found profitable to pay premiums to both men and foremen when a department proves to be especially efficient in this particular. This system is valuable whatever system of pay is used. The "earnings per hour" will often reveal an important story. These data will indicate when the job should be investigated and prove invaluable in cases where yearly adjustments of piece rates are made, especially when dealing with the union.

Balancing of Expenditures for Labor and Materials with Cost Record.—The limits of this article will not permit of any lengthy consideration of this subject. Ordinarily all costs are extended and totals of materials checked against stock records, and totals of labor against wages account. The values of stock in the stock room can be secured by means of a proper stock account showing debits and credits for receipts and deliveries. The manufacturing account will in like manner indicate the value of stock in course of manufacture. With the use of a proper stock-card system, rigidly adhered to, accurate inventories can be taken easily. A clerk skilled in the use of a slide rule can perform the calculations very quickly. This subject, however, is one requiring careful consideration. Often, if the system is properly devised, much detail work can be avoided without impairing the accuracy of the counter checks.

Records and Reports.—We now have a mass of data from which can be compiled a large number of most interesting reports. Only one part of this important subject can be touched upon in this article. Many others, however, such as auditors, purchasing agent, inspection, stock, cost, etc., tell valuable stories. All reports should be made by a

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* The Engineering Magazine, August, 1902.

| Week Ending | Output | | No. Employees | Time | | Pay Roll | | | | | Average Rate | | Cost Operation | Supplementary Machine Rate | % Jobs Reaching Standard Time | Increases Decreases | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Earnings | | | | | | |
| | Mach-ines | Points | | Total | Over-time | Total | Labor (Direct) | Piece Work | Day Work | % Piece Work To Total | Piece Work | Day Work | Per Point of Output | | | Where ? | Why ? |
| | | | | | | | | | | | | | | | | | |

DEPARTMENTAL EFFICIENCY REPORT. DEPARTMENT NAME IS ENTERED AT THE HEAD.

special department or by one person. In the case of a small concern, the cost clerk should attend to this. All data necessary for reports or records of any character should be sent to this cost clerk. In addition to the data already mentioned, he should receive reports from which to compile the general factory and commercial charges, reports showing all expenses of running each department, number of employees, output, etc. As many reports are comparative, and the question of output usually enters into these, a better basis than mere "number of machines produced" is often necessary. Often the "cost of output" is a better basis. The term "point" may be used to represent any fixed value, as $25.00. All values of output can be reduced to "points," and the results made to serve a number of purposes.

Departmental Efficiency Reports.—This cut represents a departmental report devised and used by me. A report along similar lines will generally serve as a good basis for judging of the working efficiency of a department. The result of any period should be compared with some other corresponding period that can be considered a fair basis for comparison. Results of one month may be compared with either the results of the corresponding month of the preceding year or the average monthly results of the entire preceding year, or an average monthly result of corresponding seasons of business. Such comparisons will give a clear idea of whether or not a department is improving its working condition. Especial attention should be directed to the piece-work and day-work records. It is almost invariably the case that the percentage of day work will increase as work grows slack, unless the departments are very closely systematized and supervised. The reasons for and results of such increases are apparent.

Consultations and Meetings with Heads of Departments.—All heads of departments should be consulted concerning their departmental records, reasons required for any deteriorations, and commendation bestowed for improvements. Large frames containing ten or more swinging blackboards upon which such forms are painted can be used with very good results. The records for each department are filled in with chalk, and all reports are considered in an open meeting of foremen and assistants. Such a method of procedure soon brings results. A foreman with a poor departmental record may feel that he has good reasons for a poor showing, but the fact that this showing will appear before his associates will augment, to an astonishing degree, his desire and efforts to improve it.

Factory Output and Cost Report.—This report will give a general idea of factory efficiency. The separation of costs as shown makes it possible to locate any increase or decrease immediately. Any factory manager will be richly repaid by such a series of reports.

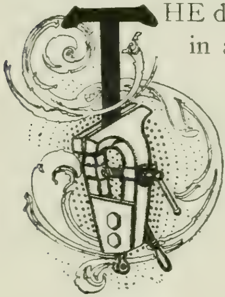
FACTORY OUTPUT AND EFFICIENCY REPORT.

| Week Ending | | No. Employees | Output | | | Hours Worked | | Pay Roll | | | | | | Costs | | | | | Increases Decreases | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year | | Type | No. of Machines | Points | Total | Overtime | Total | Labor (Direct) | Piece Work | Day Work | % Piece Work To Total | % Jobs Standard Rate | Material | Assembling | Machining | General Charges | Total | Where? | Why? |
| | [illegible] | | | | | | | | | | | | | | | | | | | |
| | [illegible] | | | | | | | | | | | | | | | | | | | |
| | [illegible] | | | | | | | | | | | | | | | | | | | |
| | [illegible] | | | | | | | | | | | | | | | | | | | |
| | [illegible] | | | | | | | | | | | | | | | | | | | |
| | [illegible] | | | | | | | | | | | | | | | | | | | |
| Total | [illegible] | | | | | | | | | | | | | | | | | | | |
| Total | [illegible] | | | | | | | | | | | | | | | | | | | |

# THE RELATION OF THE DRAUGHTSMAN TO THE WORKSHOP.

*By W. H. Booth.*

**One of the points of international difference in engineering practice most interesting to a trained observer is that of the position and treatment of the draughtsman. To a German engineer visiting America, for example, the difference in attitude of superior to subordinate—of chief to draughtsman—is so great as to be startling, and Mr. Lüders, writing in this Magazine in September and November, 1901, found in this one matter a very large factor in American engineering success. Mr. Booth's paper following, therefore, deals from the British viewpoint with a question of very great practical importance.—The Editors.**



THE determination of the draughtsman's proper functions in an effective shop organisation is a matter of considerable importance, and round it in its many phases much discussion, plaintive, acrimonious, and controversial, has arisen. To begin with, the very term is vague; for the name of engineer, which includes it, includes also, in British parlance, a vast concourse of men, ranging from the designer of a Forth Bridge or of a steam engine producing a horse-power hour for 11 pounds of steam, to the manufacturer of iron bedsteads or the driver of any type of engine.

The position of a draughtsman is by no means always a pleasant one. His duty in many cases consists very largely in adapting existing drawings to fresh purposes, effecting minor changes, and generally doing much routine work that possesses a minimum of engineering and scientific interest. He comes very little into contact with the outside world, and the utmost recognition he obtains from his immediate superior is contained in the words "my draughtsman," which are used when his work, perhaps, comes under the notice of some customer in the course of an explanation of what is being done. It is often said that he gets all the blame when things go wrong and secures none of the credit for what scores a magnificent success. There is much truth in this view, and it is doubtful whether the occupation will ever become popular unless remodelled on new lines. On the other hand, there are large numbers of men engaged in drawing who have very little preparation for the work. No youth ought to go into the drawing office as a sequel to having learned to draw neatly at a technical school, for example. He should go first into the shops, where he will see drawings of a practical kind, learn what dimensions are necessary on a drawing, appreciate the value of an incorrect drawing correctly figured, and in fine, learn when a drawing is not a drawing and when it is.

The chief draughtsman of a certain colonial railroad known to me once insisted that the draughtsmen under his charge, who were frequently called upon to make sketches in the running shed, should actually make these sketches to scale, and he insisted they should figure these sketches with a particular pattern of figure, fractions being shown thus, ¼″, with great regularity of style, and he insisted on the correction of a full-size drawing of part of a Bissel truck because a part which was correctly dimensioned to 24 inches actually scaled 1/64 inch from truth.

Many good men who would be welcomed in the drawing office today have been barred out in past years, because they could not draw nicely. The art of drawing nicely is not of particular value today in an engineer's office. It is not always the neatest writers who spell best and clear writing may but serve to show up more clearly bad spelling. A large proportion of the work of a drawing office is mere routine copying and "fudging in"—work of a kind that can soon be acquired by men who are mechanics rather than engineers in mind. The engineering is done by the chief draughtsman, and the others leave the drawing office after they have had a sufficient experience, or continue more or less as drudges. But there is and always has been a certain leaven amongst the draughtsmen to whom the engineering world is indebted for nine-tenths of its advance in engineering—men who understand principles—engineers, in fact, of all round ability, who are really the apostolic successors of the old millwrights of the stamp of the Rennies or Fairbairn. Every establishment may be said to possess the sort of draughtsman it deserves. There are many, too many, where he is expected to lie prone upon his board all day. He must never leave the office; the shops are barred to him; he is officially altogether in the dark as to the prices of the raw materials which he may select for constructing the work he designs; he may spend weary hours on a design to have it contemptuously blue-pencilled by his superior in position, who, as one might expect in such a place, is often far from his equal in ability.

A word here on the prone position. This is simply ridiculous. It wastes room, it injures the man physically, and it is quite needless.

With little practice any draughtsman can acquire facility in working on a vertical board. His T-square is balanced and carries a small ledge to stiffen it and to hold pencils and small tools. Another ledge at the bottom of the board carries all other tools. The board is adjustably balanced at any height, so that drawing is done at the level of greatest convenience. The operator stands upright, or uses a stool, and suffers less in eyes and nothing in chest. There is no excuse for the flat board. Artists have long used the vertical board and easel.

Conventionalism held the draughtsmen for long. A mechanical drawing had to be made on certain lines and rules, and it was copied by tracing. The sun print has done much to abolish the old system, but before this some men had broken loose from tradition and made their drawings with all black thick lines and put in dimension lines by hand, *i. e.,* without a ruler, and they abandoned all printing and wrote everything on the drawing; such drawings were even made on linen-backed paper and sent into the shops on their own drawing boards on which they were nailed with little copper tacks.

In the old days there was constant rivalry, or rather ill feeling, between the drawing office and the pattern shop and machine shop. Pieces would be drawn involving needless expense in patterns, and these needless expenses extended even to the foundry, while often heavy pieces had to be hand-fitted because they were too large to be done on the big planer. Such conditions were due to sheer ignorance on the part of the draughtsman as to what the limits of the machine were, or to indifference resulting from his acting up to the official ordering of his status—that he had no business with the shops. When the drawings went into the shop the draughtsman had done with them. To get out the work was the duty of the foremen, and the bolts to put the work together were obtained hap-hazard in many places.

There were scores of parallel practices, although perhaps no one place possessed them all and the smaller places possessed the fewest, and were really run on sounder lines than the larger works. In a small business the draughtsman is usually the engineer. He gets out all the plans, sees to construction in the shops, supervises erection outside, orders every scrap of material, and gets out estimates for new work. He carries the whole establishment on his shoulders. In his case drawing is reduced to its smallest proportions, and most details are perhaps mere hand sketches done in copying ink and copied onto buff sheets. There is no time for elaboration. The man has too much to do. When he disappears he has no competent successor. Now if this man and his methods be taken as a starting point for the organisation of a large shop, the engineering department—a wider and better term than "drawing office"—might be placed on a sound footing. It ought to be the centre whence all emanates. In the first place, there should be lists of all machine tools, with the minimum capacity they can machine in length, breadth, and height and the maximum they should usually be expected to do. Detail drawings might even be numbered with the machine on which the draughtsman had designed they should be machined—not necessarily to be obligatory on the shop foreman, but as a guide for his use. No unusual work ought to be undertaken except in consultation with the pattern shop and foundry or forge. An example will serve to illustrate the importance of knowledge of all the particulars of a job. A cylinder or other drawing goes into the shop. The patterns for this may be substantial and expensive, or they may be cheap and consist largely of mere strickle boards. The expensive pattern costs say £10 and it costs 5 shillings in labour to mould it. The cheap patterns cost £3, but cost 10 shillings in labour to mould from them. They have therefore economised £6 15 shillings on a single casting. But if one hundred castings are wanted the pattern and labour cost of the expensive pattern will be £35 and of the cheap pattern will be £53. Thus the more expensive pattern is fully justified if a large number of castings are wanted, and if such matters are not worth communicating to all concerned then it is time to engage new foremen or a new manager.

When an order is to be executed, it should be put into the hands of the drawing office to decide on the method and materials of construction. The general scheme having been prepared, it is then to be decided what existing drawings can be utilised and patterns can be used from store, and what should be made new, and the extent of such patterns must be decided in accordance with the extent of their immediate and probable future use, as above suggested. A selection must be made of the materials to be employed, and here again many factors may enter into the estimate. Ease of manufacture may justify a greater expenditure on material. The possession of a heavy stock of a certain article may justify its use where a cheaper article would have been amply good enough if new material had been purchased. Thus one should not purchase new 3/4-inch bolts where a stock of 7/8-inch bolts of correct length is unlikely to find future employment. A stock of 1/2-inch plate might on occasion be drawn on where 7/16-inch was sufficiently strong. These are all points that should be within the knowledge of the office to utilise and within their power to decide. For this purpose, therefore, the schedule of stores ought to be kept up to date and a copy kept in the office. This brings up the question of stores and the relation of the stores department to the other departments of the works. General stores of the soap and paint variety may be kept up by the head of the stores department, but the store of steel, bolts, plates, and in fact all constructional material, should never be ordered except in agreement with the drawing office, who should know the probabilities of the future and their own intention as to changing their practice in respect of any particular detail.

The design of large pieces has already been referred to as dependent upon the power and capacity of the machines upon which they are to be made. It might happen that a certain machine would be employed on other important work at the time that pieces were coming forward for a different contract. Some amount of foresight is required for such cases, and it might be wise to alter a design in order to avoid such a contingency, or to take the opportunity of purchasing a new machine, the cost of which would be offset by the economy to be secured on this particular order. It is only by attention to points like this that the works can avoid overloading certain machines with work while other machines stand idle.

The present very usual system of getting out estimates for new work in an estimating department quite distinct from the engineering department is wrong. The estimating department ought to be a part of the engineering department, and generally the engineering department ought to be the intelligence department of the establishment to which all information should be sent and from which the orders should emanate in respect of the use and purchase of materials and the general methods of constructing. The department would not interfere with the duties of the shop foremen, on whom of course must always rest the responsibility of getting out work. But before this duty comes to them they should be consulted by the draughtsmen on any more than ordinary operations, and the shop foreman, if worthy of his position, will be of the greatest value to the draughtsman, who will indeed very largely depend on his consultations with the foreman for keeping himself up to date in shop methods and in data relating to the time required on various operations. The time cost of an operation cannot be too exactly known. A thorough knowledge of time would enable piece work to be correctly priced out, and would prevent those errors which now cause so much trouble when rates are cut to correct them. Piece-work prices, in fact, very properly fall under the engineering department. A mere clerical department cannot properly take hold of this class of work—cannot, in fact, take hold of it at all without help. A prime-cost department and piece-price department ought not to be clerical departments assisted by engineers, but ought to be an integral part of the engineering department, with such clerical assistance as may be required. The relegation of the drawing office to a subordinate position is sure evidence of the inability of the management in engineering questions.

For an engineer student some shop training is necessary to familiarise him with practical work, but by far the larger portion of his time ought to be spent in the engineering department—or, to use the commoner but less preferable term, the drawing office. In that department he would not merely learn to draw, but he would learn what weight to attach to the dimensions of a machine tool; he would become familiar with the lengths, sizes, and weights of materials of construction; he would be made acquainted with the sources whence such materials could be obtained, and would discover to what extent prices fluctuated; and he would acquire a sense of proportion as to the influence of prices and of wages upon construction. Mere drawing of a plan is not, or should not be, the end and aim of the drawing office. An engineer who knows what he wants can always make a drawing fit—perhaps not an old-time, fine-lined, shaded and artistic production, but one that another engineer will understand. The drawing office as it should be is the place above all others in which an engineer could be trained to a knowledge of his business in all its aspects, and if it were such a place, its value to the works of which it forms the brain would be very great.

At most places the work of the engineering department is done more or less badly because it is split up among other departments—estimating, stores, testing, manager, chief draughtsman, and shop foremen. It ought to be organised into one department under one head who will subdivide the duties among the staff, and in this way there will be harmony between the various operations of the works and an efficiency and economy at present rarely to be found. The constant intercourse between office and workshop will contribute greatly to the avoidance of red tape on the one hand and of careless work on the other hand. Incidentally it may be pointed out that all manner of operations that belong properly to the office are now done by shop foremen, who in place of looking after work become little better than junior draughtsmen. For example, it is no proper work for a foreman to hunt over a drawing in order to make out a list of bolts for the forge or stores. A sheet of bolts is as properly a "drawing" as is the drawing of a crankshaft, and should form part of the portfolio of drawings for each job. There should be a separate sheet for bolts to be drawn from stock and bolts to be forged in the smithy. Bolts are named as an illustration merely as of almost universal employment, but the same arguments will apply in other directions.

The familiar saying that there are no old draughtsmen, is very true. The position is not what the intelligence and training of its best members entitle it to be, and if men are not killed off by the prone position they leave the drawing board for other work. Better management would place such other position very often within the radius of the engineering department.

Much of the recent discussion on the position of draughtsmen has taken place from the individualistic view of the correspondents themselves. They have recognised that there is something wrong with their condition, but have not realised that it is the system which is at fault and that the great body of draughtsmen can never be satisfactorily employed until their field of duty is widened. Making drawings without constant access to the shops is bad all round—it involves harder work and cannot pay the employer. Nor under ordinary conditions can a draughtsman properly fill up his day on close drawing. He ought to be an engineer, and being one should be expected to have an engineer's knowledge.

With a wider field of operation, there would appear no doubt a wider gap between the different classes of men now classed generally as draughtsmen. Many who now pass for draughtsmen would be graded as tracers, or return to the shops. This opens a new field of discussion beyond the scope and space of this article. Suffice it to say that engineering employers have willfully maintained their workshops in a dirty condition, and may thus fairly be charged with having invited a dirty class of workers and with having set themselves against the tidy superior man. Men of the stamp who tend to the workshop in America are driven out of old-style British shops by dirt, and until there are a fair number of new-style shops the number of superior workmen will not much increase. The lower grade of draughtsmen would make good shop workers in cleanly surroundings. It is all the fault of employers, not that their workmen act so blindly in obedience to ill-informed leaders, but that there is not an entirely different class of men to deal with—men who have education enough to repudiate false teachings. Employers have invited their workmen to be dirty and have got what they invited. The reorganisation of the drawing office is but a part of the whole necessary scheme of shop regeneration. tion.

# EDITORIAL COMMENT

MR. ARCHER BROWN, in his strong, temperate, and conservative review of the iron-trade outlook which begins this number, touches upon one or two questions so actively disputed that his sense of fairness leads him to give the opposing arguments, rather than to attempt to state any final verdict. He says, very truly, that so long as the present remarkably good times continue in the United States, none of these political or economic problems are likely to be taken up for final settlement. But when the time comes when the United States must deal again with the trade of the world—and "it will come," Mr. Brown says—some of these determinations will be no longer delayed, notably the tariff question. It is certain that a very strong undercurrent is setting toward tariff revision, and will come to the surface as soon as the flood tide of prosperity is checked. Now, everyone is too busy or too indifferent to question closely the protectionist propaganda. Meantime the high-tariff worshipper bows himself in the house of his gods. "A defender of the protection system has only to point to the unexampled activity of the United States, while her great trade rival is languishing in business depression," to give his answer. So says Mr. Brown, assuming for the moment that point of view. It is precisely the style of answer the protectionist would and does give, and it would satisfy for a moment no one but the protectionist himself, nor him very long after a well-informed free-trade cross-examiner had had him in hand.

Suppose the protectionists' interlocutor, straying from the narrow track of vision measured out for him, should chance to turn his eyes on protectionist Germany, stricken with an industrial stagnation beside which the "languishment" of England is the very hum of busy activity. How would *that* comparison affect the sufficiency of the protectionist "answer"? Or suppose he should chance to turn back a paragraph or two in his industrial history, and look at the situation four or five years ago, when free-trade England was teeming with business and protectionist America was "languishing"—languishing so pitifully, indeed, that in very despair she sought those foreign markets which, Mr. Brown says, realize for manufacturers "the best prices, in times of depression at home"—those markets which England always enjoys.

Suppose, indeed, this unconvinced free-trader should examine closely into conditions in languishing England, and find that her "business depression" (already, by the way, rapidly rising again to normal) was after all only a somewhat relaxed business activity; that, instead of the dire results experienced in America in 1897-8, and in Germany in 1900-1—panics, failures, collapses of inflated ventures, shrinkages of overblown combinations, ruin of investors and painful reorganisation of survivors—instead of this, British "business depression" was displayed only by a smaller surplus of orders, a somewhat decreased pressure of work, a decrease of the rate of increase, rather than any decrease of trade itself. Suppose he should see not only these facts, but incidentally that the broad foundations of Britain's free trade with all the world spread so far and were laid so deep that no national depression could seriously menace or weaken the great structure—that her valleys of depression were small and shallow, while those of protectionist America and Germany were abysmal.

What would be left of the force of the protectionist's "answer"?

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It has often been said of late that the age of trade has superseded the age of conquest. Industry, not war, seeks and demands new and ever-widening worlds. Napoleon's spell lies not alone in what he did, but in the knowledge that such things are no longer doable, or even thinkable. He is the last of the military conquerors, and the world, though still half-fascinated, breathes freely in the feeling that the race is extinct.

But it is not so generally believed that the change is in manifestation only. The type persists; the sphere alone is changed. The flippant term "Napoleon of Finance" embodies a fundamental truth. The same restlessness of conscious power, the same hungering for empire, the same craving for the intoxication of victory, now find in the field of industry the outlet that once was to be found only in the field of battle. And the same glamor of immediate success dazzles the people and throngs them about the victor, delirious in the glory of the present, careless of the stability of the future. But the same law underlies all nature, and will not be denied. The overblown bubble will burst—the overstretched fabric will break—the unstable structure will fall. The retreat from Moscow, Leipzig, Waterloo, were only incidents of an inevitable result—not prime causes of Napoleon's ruin. Contempt of economic and political conditions, contempt of men and the natural rights of mankind, extension of the State beyond the powers of statesmanship to manage, reliance on military prowess as the supreme force—these brought the whole vast Empire to a pass where military skill was utterly overwhelmed by the reassertion of natural forces.

The analogy is plain. The American leaders of finance, beginning with undertakings which had economic justification, but since drunken with success, have expanded their campaign to the limits of dreamland. Not content even with control of one industrial kingdom, they would gather them all into one empire. To the conquered world of manufacture they would add the conquered world of transportation. Making, selling, distributing—all are to be ruled by the one head. Individual initiative, emulation, competition, are to be set aside. "Community of interest" is to be the economic motive of the future. And by that policy the Napoleons of Finance, gathered in their little council, propose to direct the world.

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So far, as with Napoleon's first armies, the madness of battle and the thirst for spoils have held together their followers; the paralysis of fear has held back their opponents. But because, and to the extent that, they have rejected the wisdom of the founders of the states they are undertaking to combine into a towering empire, they are rushing toward wreck. When the "financier" leaves the engineer and the industrial manager out of his counsels, the end of his triumphant progress is in sight. When success in floating securities is put above success in mechanical invention, in works organization, in labor handling, and in cost reduction, the defeat of the "American invasion" is close at hand.

For some irreverent watchers find another sort of *rationale* closely interwoven with the desire of conquest, and that is the desire of "unloading." "It is all very well," says the N. Y. *Evening Post*, "for corporations and banks to pass on the inflated securities from one to the other, but all is in unstable equilibrium unless a final resting-place can be found in the small purchaser, who cannot, in turn, unload. 'Oh, that I knew where I might find him!' is the sigh of the would-be unloader, longing for the small buyer, in great numbers, but not of too great perspicacity. Of what avail is it to have heaps upon heaps of common stock, which you have got as a bonus, unless you can unload?" "The only people who have reason to fear Trusts," said Andrew Carnegie, "are those who trust them." But of these there are yet many—"the widow with small savings; the clergyman with a tidy sum laid up for a rainy day; the executor with trust funds to place where they will yield a secure return for the orphans under his charge." These throng the recruiting stations of the Napoleons of Finance, who gather in their millions and prepare conscription (pardon! *sub*-scription) lists for their hundreds of millions. A like recklessness led to Napoleon's winter campaign in Russia. What will be the suffering, and what the proportion of loss, in the impending retreat of the American Napoleons of Finance?

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It has been pointed out that one of the immediate consequences of the strike in the anthracite coal regions will doubtless be the more general introduction of machinery for all operations possible, and there is no doubt that numerous advantages would result from this course. Apart from the effect which this may have upon the labor situation, it is to be encouraged, as should be every change which removes from the shoulders of human beings laborious and difficult work which can be performed by machinery.

There is another engineering problem, however, which the scarcity of anthracite coal should bring into prominence, one which is at least partially solved, and which is capable of complete solution if it but receives the commercial attention which its importance demands. The only objection to the general use of bituminous coal for all purposes is the production of smoke which generally accompanies its combustion. No one objects to soft coal in itself, but every one is opposed to the production of the smoke, soot, and cinders, fouling the atmosphere and rendering personal cleanliness difficult, if not impossible, in large cities.

The question therefore resolves itself into the rigid enforcement of ordinances against the production of smoke within city limits, regardless of the nature of the fuel employed. A large portion of the smoke produced by the use of bituminous coal results from attempts to burn it in furnaces originally designed for anthracite. In such cases the production of smoke is inevitable, since the relation of the grate to the boiler surface, or other point of application, is incorrect, the air supply is lacking in amount and location, and the general conditions for complete combustion are altogether absent.

When it is understood, however, that the supply of anthracite coal is distinctly limited, even when no labor troubles exist, it is evident that no time should be lost in equipping the furnaces in large cities with proper appliances for burning soft coal without the production of smoke. That this can be done is not denied, but that it would cost some money to make the change must be admitted. At the same time it is a question if the expense which has already been incurred in the purchase of anthracite coal at abnormally high prices would not have sufficed to have equipped all the furnaces in which that coal has been burned so that they might hereafter use bituminous coal without incurring any unfavorable comment by reason of violation of smoke-prevention ordinances. The resetting of steam boilers is by no means a simple task, but it need not be done immediately, the limited life of a boiler rendering its replacement inevitable within a few years in any case, when the change in furnace construction could be made at a nominal cost in most instances.

The present condition of affairs should lead steam users to consider very seriously the modification of their steam plant in such a manner as to render them altogether independent of the character of the fuel to be used, and thus take them out of the present dilemma of paying exorbitant prices for a special kind of fuel, or of violating ordinances which all must admit should be respected for the general good of the community.

* * *

LOOKING still farther ahead in connection with the generation and distribution of power in large cities, it is evident that the time must come when the generation of steam by the burning of solid fuel shall be abandoned within city limits. Apart from the extent to which the air is fouled by the discharges from furnace chimneys, the question of the inferior efficiency of many small furnaces as compared with large generating plants must be considered. When the greater additional economy of the internal-combustion engine is considered, it is evident that the true solution of the smoke-prevention problem lies in the substitution of the gas producer for the wasteful coal furnace, and the doubling of engine economy by the employment of the gas engine in place of the steam engine. The facility with which fuel gas may be distributed renders it possible to have the gas producers situated without city limits, while the construction of large gas engines is now so well assured a fact that no limitations need be placed upon the size of the local power plants. In many instances the power may be generated altogether without the city, and distributed electrically, thus doing away altogether with the installation of prime movers in the city. That such a plan will become the ultimate solution of the smoke problem can hardly be doubted, and while it may not be realized immediately, there is no one thing which can help more to bring it about than the utter disregard which has been shown of the rights of the user of fuel by both parties in the present labor dispute in the anthracite coal regions.

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THE commercial importance of Canada to the United States has been recognized by THE ENGINEERING MAGAZINE for some time, as witness the succession of articles we have published during recent years dealing with engineering and mining development in the Dominion. From Nova Scotia to British Columbia are to be found some most significant undertakings—significant especially in a wide view of the tendencies of industry and trade. And not only at home, but as far as the West Indies on the Atlantic side, and as far as the Orient on the Pacific side, Canadian capital and energy is extending its sphere. It cannot be said that the trade relations of the United States with this nearest and most promising neighbor are anything like satisfactory, although the opportunities for mutual advantage in Canada's rapid advance are many and great. The movement for tariff revision, which is gaining irresistible headway in the States, might well be directed early to improving our relations with the Dominion across the northern boundary.

# REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

## ENGINEERING CONSIDERED AS APPLIED SCIENCE.

### THE COMMERCIAL VALUE OF THE THEORETICAL MAN—SCIENTIFIC METHODS AS AN AID TO MANUFACTURE AND COMMERCE.

*An Editorial Discussion in "Engineering."*

IT has long been the custom in most civilized countries to differentiate clearly between the theoretical and the practical man, and very often the latter has felt it incumbent upon himself to disclaim a knowledge of the theoretical side of his subject in order to emphasize his supposed practical ability. This curious separation of two elements which naturally appear to be most necessary to each other, is now, however, becoming less frequent than formerly, and observant men are perceiving that in those countries and those establishments in which theory and practice are most closely united the greatest commercial success is being attained.

While it is not always safe to assume that events which appear in a certain sequence bear the relation of cause and effect, or even that they are all effects of some preceding cause, yet when such relations are observed again and again, the matter is at least worthy of investigation.

In a recent editorial discussion upon the subject of Science and Practice, *Engineering* compares the practical adaptation of scientific methods in England with those in other countries, and shows that in every instance in which the combination has been thoroughly effected the control of the industry under consideration has been secured.

Thus, in Great Britain, mechanical engineering has been made the subject of exhaustive theoretical and scientific study, and the results of these studies have been promptly and effectively appropriated by the builders of tools and machinery, so that in these lines Britain is second to no other nation. In the chemical trades, however, the situation is altogether different. Thus up to the year 1872, Great Britain held a commanding position in this department of industry. Since then, however, the energy with which the latest scientific work has been applied to practice in Germany has resulted in a greatly changed condition of affairs. That this change is due to the proper application of scientific research is most evident. Thus in the aniline color industry, in which Great Britain has undoubtedly neglected the scientific side of the work, not 5 per cent. of the dyes used are of domestic origin, the balance being mainly imported from Germany. In contrast to this we see the commanding position held by the British representatives of the Solvay ammonia soda process, an industry in which the scientific and technical side has been maintained well in advance of the Continental establishments. Another example of the manner in which the application of scientific research has resulted in the loss of position to England is seen in the matter of optical glass, an industry in which Britain at one time held the lead. Here the firm of Zeiss & Co., of Jena, and its associates, by sheer dint of painstaking research and investigation, assisted by Government liberality, grasped a line of manufacture entirely in other hands, and to-day holds a supremacy which England might well have maintained had her manufacturers seen fit to give proper attention to scientific methods and resources.

A notable instance of the enormous commercial advantage resulting from the application of science to industry is seen in the metallurgy of iron and steel. In the course of a recent address at the Stevens Institute, Mr. Andrew Carnegie affirmed that the great advance of his firm in the manufacture of iron and steel lay in their early employment of a competent chemist, a spectacled German, by the way. By a proper analysis of ores it was found that suitable material, for which a high price had formerly been paid, could be obtained at a much lower figure, the cheaper ore not having been thought worth using by the "practical" men who had previously made the selection. By the most rigid practical use of the latest scientific methods of investigation, the great aggregation of works now controlling the steel trade of the United States has been built up, according to the authoritative statement of Mr. Carnegie himself.

The same is true on the Continent. Both in Germany and in France the chemical laboratory and the testing bureau form most important elements in the success of such works as Krupp's or Creusot. The result we see in the advance which Krupp has made in the construction of armor plate, and in modern artillery by Canet at Creusot. Alike in England, Germany, France, the United States, we see the industries which have availed themselves of the work of the scientist, pushing to the front and controlling the department of work to which they are devoted. Results such as these are not to be explained away; they need no explaining away. Instead of endeavoring to show that the success may be due to some other cause, or of arguing or discussing the subject at all, all energy should be devoted to a determined effort to unite science with practice in every conceivable line of work. Empirical methods must be used when rational ones cannot be found, but the search for the rational method should never be relaxed, for we may rest assured that the man with the rational scientific command of his work must surely overtake the man of empirical routine.

# THE COMMERCIAL PRODUCTION OF OXYGEN.

A PRACTICAL APPLICATION OF LIQUID AIR—FRACTIONAL DISTILLATION DIRECTED TO THE SEPARATION OF NITROGEN FROM OXYGEN.

*Prof. Von Linde, in the Zeitschrift des Vereines Deutscher Ingenieure.*

AMONG the important papers presented at the recent meeting of the Verein deutscher Ingenieure at Düsseldorf may be noted that by Professor von Linde, upon the commercial production of oxygen by the fractional distillation of liquid air. It is to Professor Linde that we owe the original development of the cumulative process of refrigeration, by means of which it has been found possible to reach the critical temperature of air, and thus liquefy it by compression, and his paper upon the practicability of thus making a useful application of the discovery is a matter of present interest. The paper is given in full in the *Zeitschrift des Vereines deutscher Ingenieure.*

The critical temperature of air at the pressure of the atmosphere is about—191 degrees centigrade, and until this temperature is attained the air cannot be liquefied by compression. The principal constituents, the oxygen and the nitrogen, however, have different boiling points, the nitrogen evaporating at —195.5 degrees, while the oxygen does not assume the gaseous state until the temperature has risen to —182.5 degrees. It is this difference of 13 degrees between the two boiling points which renders it possible to separate the oxygen from the nitrogen. As a matter of fact the evaporation reduces the total quantity of liquid to a readily calculable extent. Since there are four cubic metres of nitrogen to one of oxygen about 60 per cent. of the liquid will be evaporated when the remaining liquid consists of equal parts of oxygen and nitrogen, and if pure oxygen is required, the evaporation may be carried to any further extent desired.

It is manifestly impossible, however, to produce oxygen by this process on a commercial scale if the supply of liquid air is to be maintained by the usual process of cumulative cooling and compression. To liquefy a cubic metre of air requires the expenditure of 2 horse power, and of this cubic metre but one-fifth is oxygen. It is therefore necessary to devise some less expensive method of obtaining a continuous supply of liquid air.

Since the greater part of the energy expended in producing liquid air is required for lowering the temperature, it is evident that this can be saved by a judicious use of the cold produced by the evaporating nitrogen. Since the oxygen is also most useful in the gaseous state, the cold produced by the entire evaporation of a given quantity of liquid air may be used for cooling an equivalent quantity of fresh air drawn from the atmosphere, and the only expenditure of power required is the small amount necessary to liquefy it after the critical temperature has been reached.

In this respect the method of Linde is identical with that already described by Pictet in a paper presented before the Société des Ingenieurs Civils de France and reviewed in these columns. The principal difference between the two systems lies in the detailed construction of the apparatus, Professor Linde employing a "counter-current" cooling device practically identical with that used by him in his original apparatus for liquefying air. In his present paper he gives details of a larger arrangement adapted for the evaporation and liquefaction of air on a commercial scale.

It will be seen that the whole operation is a very simple one, both in theory and practice. A given quantity of air requires that a large quantity of heat shall be abstracted from it. When this same quantity of liquid air is permitted, by evaporation, to return to the gaseous state, it abstracts from surrounding bodies, the same quantity of heat. This abstraction of heat is effected just as well if the constituent oxygen and nitrogen are permitted to evaporate successively as if they evaporated together. The apparatus need only be so arranged that the evaporating nitrogen and oxygen are brought into close proximity to the incoming air which is to be liquefied, and these details may readily be arranged in more than one manner.

Naturally the principal question connected with the whole subject is that of the cost. The practical uses of pure oxygen, or even of a rich mixture of oxygen and nitrogen, in the arts are numerous and unquestioned, if only the price can be brought within commercial limitations. Professor Linde gives some data which may serve to indicate the possible cost of making oxygen by the fractional distillation of liquid, and the use of the cold thus produced to yield a fresh supply of liquid air for the continuation of the process. At the works of the Linde Ice Machine Company, at Munich, an experimental plant of 150 horse power has been erected, and this has been in operation for several months. It has been found that, by the expenditure of 100 horse power there can be produced 100 cubic metres per hour, of a mixture consisting of equal parts of oxygen and nitrogen. For many purposes this rich mixture is ample, and in metallurgical operations and the like it may find extensive uses. The production of pure oxygen is naturally more expensive, but as the result of his experiments Professor Linde states that it can be produced at the rate of half a cubic metre per hour per horse power. If therefore the cost of power in any locality be given, the cost of oxygen can be readily determined.

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# MODERN BASE-LINE MEASUREMENTS.

## THE RAPID AND ACCURATE WORK OF THE UNITED STATES COAST AND GEODETIC SURVEY ON THE 98TH MERIDIAN.

*John Hayford, in Engineering News.*

In making a geodetic survey the accurate measurement of the base line upon which the system of triangulation is developed has always been considered the most important feature of the work. Various systems have been devised for enabling the engineer to measure bases of several miles in length with a very high degree of precision, some of these methods being so elaborate as to require an equipment resembling an astronomical observatory with the services of a staff of experts.

In striking contrast to the excessive elaboration of some of the systems which have been developed, is the business-like plan adopted by the United States Geodetic Survey in connection with the triangulation along the 98th meridian. This work, which was conducted under the direction of Mr. A. L. Baldwin, is described in a very interesting paper by Mr. John J. Hayford, in a recent issue of *Engineering News.*

The Geodetic Survey of the United States has had in hand the completion of two most important systems of triangulation; one extending across the continent along the line of the 39th parallel, and the other running along the 98th meridian from Canada to Mexico. These two systems bisect the country both north and south and east and west, and when completed will form the main framework or control for all surveys in the United States.

The plans for the triangulation of the 98th meridian provided for the measurement of nine bases at various points from Nebraska to Texas, and it is of the practical methods used in this work that Mr. Hayford writes.

The methods employed were unique. Instead of measuring one base and then conducting the triangulation to the location of the next base and measuring the latter, and so on, it was decided to measure all nine of the bases before any of the triangulation work was done. This enabled the entire work of base measuring to be done by one party, with one set of apparatus in a single season, thus eliminating many causes of discrepancy, besides reducing the cost.

So far as accuracy is concerned, the influence of a certain degree of error in the base upon the accuracy of the entire survey is discussed in an interesting manner. As a matter of fact there is a practical working limit of error beyond which any higher degree of precision is of minor importance. The errors due to the angle measurements are always much larger than the errors of the base measurement. It can be shown that very little increase in the average accuracy of the triangulation would result from increasing the accuracy of the base measurement beyond that represented by a probable error of one part in 500,000, even were the base measurement made absolutely perfect. It was therefore decided to keep within a probable error of one part in 500,000, and to devote the effort available beyond the requirements for that degree of precision to the economy of time and money. The result was the measurement of nine bases, ranging from 6,000 to 12,000 metres in length, situated in a stretch of country of more than 1,600 miles in length, the probable error of the nine bases being 1 part in 1,200,000. This work was done by a party of 10 persons in a period of six months, at a total cost of $11,075, this cost including field and office work, pay of all men, and transportation to and from Washington. The cost of the work was $160 per kilometre, or $260 per mile of base measured.

The method employed is described very fully by Mr. Hayford, while the detailed report of the work is included in the report of the Geodetic Survey. Five sets of apparatus of two different types were used, there being four steel tapes, and one bar apparatus. In addition to this there was employed the very accurate iced-bar apparatus designed by Professor Woodward, and used in the measurement of the Holton base in Indiana, this being used for standardizing the tapes and bar apparatus. The iced bar is 5 metres long, and being kept at a uniform temperature by contact with ice in a trough, the temperature error is entirely eliminated. This bar apparatus was used to establish two field comparators consisting essentially of stone monuments 100 metres apart. One of these comparators was at the Shelton base in Nebraska, and the other at the Seguin base in Texas, and by measuring these distances with the working apparatus at the commencement and the close of the work under similar conditions to those encountered in the regular base measurements, the accuracy of the work was kept within reasonable control.

For details of the work the reader must be referred to Mr. Hayford's paper, but it may be mentioned here that the work with the steel tapes was found to be fully within the prescribed limits of accuracy, while much more rapidly performed. The experience obtained in this work confirmed the general opinion of engineers that temperature errors are the most serious to be encountered in base measurement.

In this connection it is much to be regretted that the measurements did not include the use of one or more tapes made of the 36 per cent. nickel-steel alloy discovered by M. Guillaume, of the International Bureau of Weights and Measures at Paris, and found to possess a co-efficient of expansion far lower than any other material known. It is altogether possible that tapes made of this nickel-steel alloy, when once standardized, may be used for base measurements without requiring any precautions to be taken with the respect to temperature errors, the variations due to the ordinary atmospheric range of temperature being practically inappreciable.

The valuable feature about the whole account of the measurement of these bases is the intensely practical manner in which the work was carried, while at the same time full regard for the scientific requirements of the task was maintained. It shows quite as high a degree of scientific refinement to perceive the lower limit of accuracy in such work as to approach the upper limit, and the man who insists upon a degree of precision in one portion of an undertaking out of all proportion to the possible attainment in other portions, is far from being a truly scientific engineer. If all government work was performed with such a just appreciation of the proper balance between accuracy, speed, and cost as has been exhibited in the measurement of these bases, there would be cause of great congratulation, and greater satisfaction.

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# INTENSIFIED METHODS IN BUILDING CONSTRUCTION.

## HOW THE NEW BUILDINGS FOR THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY WERE RUSHED THROUGH.

*The Story of One of the Participants.*

ABOUT three years ago we referred in these columns to the plans which were then announced concerning the construction of the new works for the British Westinghouse Electrical and Manufacturing Company, at Trafford Park, near Manchester, and called attention to the fact that these works, when completed would be an exponent of American methods as applied under British conditions. Now we have, in a recent issue of the *Journal of the Western Society of Engineers* a most interesting paper by Mr. William G. Sloan, describing the manner in which American methods have been applied to push the completion of these works, regardless of British conventions and customs. Says Mr. Sloan:

"The plant was designed by Thos. Rodd of Pittsburgh, and the work of construction was intrusted to a Manchester architect, but under his supervision the work progressed so slowly that it was evident to those interested something must be done to hasten the work. It was generally conceded by English builders that it would take five years to erect the works contemplated, and now, when the proposed output of the plant was most in demand, a delay of a year or two years meant an almost inestimable loss. The question was, How can the plant be completed in the shortest possible time? The Americans interested in the business naturally looked to America for an answer to this question, and the contracting firm of James Stewart & Co. of St. Louis and Pittsburgh were asked to take hold of the work and push it through. This they agreed to do, saying they could complete the work in 15 months.

"Therefore a year ago last March, J. C. Stewart of the above firm, having gathered around him a party of six American engineers and foremen, of which party I was fortunate enough to be a member, sailed for England, and on arriving there took immediate charge of the work.

"It was evident at a glance that a complete reorganization was necessary, in the making of which we naturally met with considerable opposition, but Mr. Stewart was determined in his purpose to do the work, as far as possible, by American methods, and not many weeks passed before we had things running to our satisfaction. We found the work in charge, under an architect, of a clerk of works, who had a small office in one part of the grounds. This man had perhaps a dozen assistants, each having his little office in some part of the grounds, each seemingly as far as possible from the others. The first thing done was to build an office large enough to accommodate all the necessary force, so as to bring them under the immediate supervision and influence of the

American management. All these men had been in the habit of coming on the work at 9 o'clock in the morning and leaving about 5 in the afternoon; they were requested to be on hand when the work started and to remain until quitting time, and this request caused about half of them to seek employment elsewhere."

Following closely upon this reorganization of the office staff came the removal of slack methods among the men. First among these was the custom of stopping for a half-hour, in the best part of the morning, for tea, a custom unknown in America, though most universal in England. This was soon done away with almost altogether, and full time being made by all concerned, the output began to improve. One of the most important portions of the work was the bricklaying, and by securing the best men, and paying somewhat more than the union rate of wages, the number of brick laid per day was greatly increased. Shortly after the new administration took hold of the work the statement was made that the men at Trafford Park were laying more than 900 brick per man per day. This was received with incredulity elsewhere, the usual quantity being from 400 to 500 per day. Later on, as the organization became better, and the men became accustomed to American methods, this average of 900 brick per day was doubled on the same class of work. This caused so much comment that it was thought advisable to have the facts verified, and on the construction of the large brick stack the foremen made affidavits as to the number of brick laid per man per day. The average was more than 1,900 brick per man per day, the best day's work being 2,100 per man.

Mr. Sloan's comment upon the conditions which made such improvements possible are best given in his own words.

"That such a condition can exist is made possible by the fact that, considering the cost of material in England, the contracting prices of doing work generally are away above those of doing corresponding work in this country. To my mind this difference in cost represents what is lost by slack methods of handling work; not slack as far as quality of the work is concerned, but slack in every other way. It is something which only keen competition can overcome.

"England has been pre-eminent in so many lines of industry for such a long time that she has, as it were, been resting on her laurels, not realizing that in other parts of the world tremendous advances were being made along these same lines, and that other countries were assuming an importance in the industrial and commercial world which made England's position uncertain. Some progressive Englishmen realized this long ago, and some are just learning the lesson, but the great majority in their conservatism have it still to learn. Go into 99 out of 100 manufacturing establishments of any kind in England and examine the tools and appliances for doing work. You will probably find the same kind of machines used there to-day which were used and discarded in this country 25 years ago. So long as a machine does its work it is satisfactory; the Englishman has not yet come to the point where, by sitting down and carefully figuring out his cost account, he finds that it may be economy to discard a machine, even though it is doing good work, and replace it by one which will do that same work quicker and at less cost. It has been well said, the English manufacturer does not know the value of a scrap pile."

The most interesting feature in this whole matter appears to be the fact that not the slightest difficulty was experienced with the British workmen by the American contractors. We have been so much accustomed of late to hear all the blame for the present condition of British trade to be laid upon the workman and his methods, that it is most refreshing to see that the only apparent difficulty experienced by Mr. Stewart was with members of the staff and with customs and traditions. The former were readily replaced and the latter gradually overcome, while the workmen seems to have fallen into the new order of things with but small difficulty.

The real causes of the success of the work appears to have lain chiefly in the tireless energy of the contractors themselves, and in the fact that the sub-managers and assistants rendered most willing and efficient service. To this must be added the effect of keeping careful records of each day's work and the unsparing use of the most approved mechanical appliances wherever the work could thereby be facilitated.

# SOME ELEMENTS OF STEAM ECONOMY.

## THE MOOTED QUESTION OF THE INFLUENCE OF STEAM JACKETS AND REHEATERS IN MULTIPLE-EXPANSION ENGINES.

*Experiments at the Durham College of Science.*

AMONG the papers presented at the Newcastle meeting of the Institution of Mechanical Engineers, that by Professor Weighton, discussing some experiments on steam engine economy attracted attention, and elicited discussion. From the paper itself we make some abstracts, reviewing them in the light of experience elsewhere, and calling attention to some interesting comments which have been made upon it editorially by the *Engineer*, and by *Engineering News*.

Professor Weighton's investigations were made upon the small experimental engine in the laboratory of the Durham College of Science, Newcastle-upon-Tyne, one series being intended to determine the economical effect of reheating the steam passing through the receiver of a double-expansion or compound engine; the second series being to determine the influence of the degree of vacuum in the condenser of a triple expansion engine.

The data and results of the tests are given in detail in Professor Weighton's original paper, to which reference should be made. It is sufficient to state here the general results. A reheating coil was arranged in the receiver so that live steam could be admitted or withheld without changing any of the other conditions of operation. Trials were then made without steam in the reheater coils, followed immediately by similar experiments with live steam in the reheater.

The results of these two methods of operation are summed up in two groups; one, showing the favorable influence of the reheating and the other its losses. In the first category it appears that the reheating acts favorably in the following respects: It reduces the amount of condensation in the receiver, raises the receiver pressure, raises the mean pressure in the engine, increases the engine speed, and furnishes dryer steam to the low-pressure cylinder.

These advantages, however, are obtained at the expense of a reduced mechanical efficiency of the engine, and of an increased steam consumption per horse power developed. In other words, the consumption of steam in the reheater coils amounted to more than the saving in the cylinders. It is true the increase shown in steam consumption was very slight, while the decrease in mechanical efficiency is thought to be due to the greater dryness of the working steam, after reheating.

So far as the reheating itself is concerned, the results recall the interesting tests made ten or twelve years ago by Professor J. E. Denton upon the Pawtucket pumping engine, and the subsequent tests, also made by Professor Denton, upon a triple-expansion pumping engine used on pipe-line service. In both of these important trials, made upon a far larger scale than was possible with the small laboratory engine used by Professor Weighton, the results showed that little or no economy was attained by the use of live steam in jackets. Similar results were obtained in several tests by Mr. George H. Barrus, who, in his book recording his many engine tests, says that 2 per cent. is the most that can be expected for the saving due to jackets and reheaters. In regard to the actual influence of reheating upon the engine, Mr. Barrus arrived at the same results as Professor Weighton several years ago. Says he: "Whatever the actual economy due to jacketing or to reheating, or to both, which from the evidence of these tests appears to be rather small, there is no question but that the action of the jacket and the reheater produces a powerful influence on the steam in its passage through the cylinders. The effect upon the indicator diagrams is very marked. The use of these appliances makes the engine more powerful in view of the fact that it increases the work done by the low-pressure cylinder for a given amount performed by the high-pressure cylinder."

Professor Weighton's experiments upon the effect of a high vacuum upon economy, show results confirmatory of those known already in practice; namely, that there is no appreciable advantage in carrying a vacuum higher than 26 inches of mercury. It is doubtless true that a higher vacuum will cause the engine to produce more power, but the gain will be at the expense of a greater volume of condensing water, and the increased burden overcomes the gain.

So far as steam economy is concerned there is no doubt that the point of attack is the reduction of cylinder condensation, but with modern engines at least it seems fairly well demonstrated that the use of live steam outside of the cylinder is not an economical way to prevent condensation within it. It does the work, to a certain extent, but it costs more than it saves. Far more promising are the results attained by superheating, not only because they can be made to prevent condensation more effectively, but also because they are attained by the utilization of heat which would otherwise be wasted, the heat of the discharge gases of the boiler. As for the influence of dry or superheated steam upon the mechanical efficiency of the engine, that is a matter for engine designers to look to proper provision for lubrication, avoidance of unequal strains from expansion, and a general provision for the changed nature of the working fluid can readily enable the engine to do its work all right. The main thing to be remembered is that the machine is a *steam* engine, and that water in any other than the gaseous state is absolutely out of place anywhere in the working cylinders. When this point is assured the economy of the steam in the engine will be obtained, and it remains only to see that the gain thus secured is not offset by the nature of the method adopted to prevent the presence or formation of water in the liquid state.

It may be noted in this connection that an economy of steam does not necessarily mean an economy of money and usually it is the latter feature in which mill owners and engine proprietors are most deeply interested. The engineer of to-day must be an economist in a broader sense than was formerly considered necessary. The cost of power includes many items, such as interest, depreciation, repairs, attendance, etc., and the economy of steam which results in the economy of money is that which in the course of its attainment does not increase unduly the other elements which unite with it to make up the total cost.

## MODERN TRANSATLANTIC STEAMSHIPS.

### THE DEVELOPMENT OF BRITISH AND GERMAN COMPETITION IN SHIPBUILDING AND MARINE SUPREMACY.

*The Launch of the Next Record-Breaker.*

IN providing for the great and increasing traffic across the north Atlantic there are several conditions which must be met, and these conditions have, in varying degree influenced the growth and modifications in steamship construction. Naturally the first nation in the field, if it may be so called, was Great Britain, and for many years the great British steamship lines controlled and commanded the traffic. At first the crossing of the Atlantic was considered a feat which, if effected in safety, and with some moderate degree of comfort, was considered to have been most successfully accomplished. To-day it is a trip which is made with small concern by thousands, the cities of Europe and America often being mentioned as forming portions of a journay without referring to the existence of 3,000 miles of ocean between them.

The first of the conditions above referred to as existing in the case of ocean traffic is that of safety. Formerly this was a matter which entered largely into the selection of line and steamer, but now it is fully understood that the modern methods of construction and operation are the property of all lines alike, and that there is little or no choice in this respect. Following close upon safety comes the question of speed, and for a time the possession of the record breaker was a valuable asset for a transatlantic line. Following close upon safety and speed comes comfort and luxury, and to-day the traveller is not content with being transported across the Atlantic with safety and a fair degree of speed, but demands such freedom from care and discomfort as is made possible everywhere else for those who are in a position to demand it.

It is in this latter requirement that we may look for the success of the continental steamship lines, and especially for the great progress which has been made in the past few years by the great German lines.

These questions are brought into immediate consideration by the accounts which have appeared of the launch of the latest German liner, the Kaiser Wilhelm II, and the comparisons which this event has caused between the British and German lines in general.

For details of the latest and greatest of the German transatlantic steamships reference may be made to recent issues of the *Zeitschrift des Vereines deutscher Ingenieure* and to late numbers of *Engineering*, while in the editorial columns of the latter journal some interesting points in connection with the whole subject are brought out.

Naturally the latest developments in shipbuilding have been in the direction of greater size and higher powering, and in these respects Germany is maintaining the lead she set with the Kaiser Wilhelm der Grosse in 1897. The following table shows clearly the successive developments in the building of large steamships, and the preponderance apparent in the German vessels is most apparent.

| Vessel. | Date. | Length. | Displacement. | Power. | Speed. |
|---|---|---|---|---|---|
| Kaiser Wilhelm II....... | 1902 | 706 ft. | 26,000 tons | 40,000 hp. | 24 knots |
| Kronprinz Wilhelm ...... | 1901 | 663 " | 21,300 " | 36,000 " | 23.5 " |
| Deutschland ............ | 1900 | 684 " | 23,620 " | 36,000 " | 23.5 " |
| Kaiser W. d Grosse...... | 1898 | 648 " | 20,880 " | 30,000 " | 23 " |
| Campania ............... | 1893 | 622 " | 18,000 " | 30,000 " | 22 " |
| Oceanic ................ | 1899 | 704 " | 28,000 " | 27,000 " | 20.7 " |
| Lorraine ............... | 1900 | 582 " | 15,400 " | 22,000 " | 21.9 " |

Thus it appears that the new German ship, the Kaiser Wilhelm II, already launched, and expected to be ready for service by April of next year, surpasses all other German ships in dimensions, and exceeds even the Oceanic in length, although not in displacement. The higher powering of the Kaiser Wilhelm II is expected to give her still greater speed than her predecessors, and thus the advance in size and speed goes on.

The latest additions to the British fleet of first-class Atlantic liners, so far as high speed is concerned, are the Campania and Lucania, and these vessels are now nine years old, while the Oceanic made no attempt to claim maximum speed, being intended rather for comfort and capacity. Naturally there must be some reason for this apparent apathy on the part of the British lines, and this reason is aptly expressed by *Engineering* in the statement that "excessive speed, which means enormous first cost, and extravagant running expenses, does not pay."

As a consequence of the above view of the question, the latter examples of British shipbuilding have been in the class of large vessels, of moderate powering and speed, but of profitable character both for merchandise and passenger traffic. Thus the Celtic, of 700 feet in length, and a heavier displacement than even the Oceanic, is a recent exponent of British construction, while the Saxonia and Ivernia are the successors of the Campania and Lucania in the service of the Cunard line, and others of similar dimensions and speed might be mentioned. That these are good ships and profitable investments cannot be denied, but it must be admitted that they are not to be classed as modern first-class liners. Practically they constitute a class by themselves, a class in which Germany also has some excellent examples, notably the Pennsylvania and her sister ships of the Hamburg-American line. It is not to be admitted, however, that the faster vessels do not pay. The Kaiser Wilhelm der Grosse, the Deutschland, and the Kronprinz Wilhelm are always crowded during the season, and even at other times in the year fully 75 per cent. of the accommodations are used, although high prices are charged at all times. It is claimed that the German high-speed liners have more than paid their way on every trip, without any government subvention beyond the ordinary mail freight fixed on a basis common to all nations.

It is interesting, from an engineering standpoint, to note that the recent success of Germany in shipbuilding is not due to any advance in construction over British practice, nor to any reduction in cost of building. There is no practical difference in the design either of hull or machinery between first-class vessels of British and German construction. The German vessels are faster because they are more heavily powered for their displacement, and the rules which have been followed in their proportions are identical with those adopted in Great Britain. If British lines would order vessels of similar character and speed from British builders there would not be the slightest difficulty in having the orders filled at similar prices. It is wholly a matter of policy, not of shipbuilding. Says *Engineering:*

"The premier position in the North Atlantic trade has been wrested from us largely by the enterprise of the German shipowners, rather than by the superiority of her naval architects or the greater skill of her marine engineers. The management of the German shipping business has been admirable. The companies have had the courage to build vessels of the highest speed, and they have run them with punctuality not second to that observed on British lines. By attention to passengers' needs, by the politeness of their servants, they have gained the good will of even those belonging to the nationality they have supplanted. Their ships are managed like a good hotel, in which the comfort and happiness of the passengers is considered as well as their safety. In fact, each person who travels recognizes that he is looked on, not simply as a unit of passenger complement—a parcel of live freight—but as a guest whose pleasure is worthy of consideration."

# THE REGULATION OF ENGINEERING PRACTICE.

## THE PROPOSED LEGISLATIVE CONTROL OF THE PRACTICE OF CIVIL ENGINEERING IN THE UNITED STATES.

*An Interesting Society Report.*

AT the recent meeting of the American Society of Civil Engineers at Washington there was an interesting report presented by a committee which had been appointed to examine into the advisability of regulating the practice of civil engineering, and from the *Proceedings* of the society we make some abstracts.

This question of limiting the practice of engineering by some kind of restriction, legal or otherwise, is one which crops up repeatedly, both in the professional societies and elsewhere, but until now it has not been presented in such a definite form at a professional session, and hence the present occasion is interesting from the manner in which it has enabled eminent engineers to express their opinions.

The committee very properly included in its report the result of an investigation into the practice of other countries than the United States, since it was found that no states in the Union have enacted any laws upon the subject. In Canada it was found that enactments have been passed in the provinces of Quebec and Manitoba, these requiring membership in the Canadian Society of Civil Engineers as a qualification for practice, or, in the case of the latter province, unless the individual shall have had the degree of Civil Engineer conferred upon him by some institution of learning duly authorized to do so. The fact that this legislation practically placed the control of the Society, so far as its qualifications for membership are concerned, into the hands of the legislative body was a feature not to be overlooked. As a matter of fact these Canadian enactments have not been enforced, and are practically ignored.

In Mexico engineers are required to be licensed, after a professional training at Government schools, while in Europe no provision was found to exist. This latter statement must be understood not to include Russia, since the practice of engineering in the Russian Empire is prohibited to any but those duly authorized by the government. The correspondence of the committee with engineers in England, France, and Germany, indicates that legal regulations were there considered undesirable.

The analogy between the practice of the professions of law and of medicine was considered, and while this forms the principal precedent for the proposition to impose legislative restriction upon the practice of engineering, it was evident that essential differences exist. The protection of life and health are intimately connected with the regulation of the practice of medicine, while the attorney is theoretically an officer of the court, and as such a part of the legal machinery. A closer analogy is found in the existence of legislation to regulate the practice of architecture in several states, notably in Illinois, where the operation of the law has been found satisfactory, according to Professor Ricker.

Nevertheless the agitation for some action in connection with the practice of civil engineering has shown that very many of the prominent members of the profession are opposed to restrictive regulation. This absence of unanimity on the part of the profession renders it difficult for any desirable legislation to be secured, and even if this difficulty did not present itself, other obstacles appear. Among these may be mentioned the wide scope of civil engineering and the difficulty of defining its limitations; also the great difficulty of securing general legislation in all the states.

Unless the whole field of engineering could be covered, throughout the country, the desired result could not be obtained, even if the entire body of the profession desired it. These reasons, if no others existed, sufficiently explain the fact that the committee recommended that no action be taken by the society, and since the report was accepted, the question is disposed of for the present. At the same time it is interesting to consider here for a moment whether such action as restrictive legislation would be desirable even if it could be had for the asking. To make membership in the American Society of Civil Engineers a requisite for practice would really result in placing the control of membership qualifications in the hands of the state legislature, a condition which it is hardly to be imagined would be acceptable to that worthy society. To require the signature of a titled and licensed engineer upon all drawings and specifications would only be to invite an imitation of the practice in Mexico, where a titled but impecunious engineer can be hired to sit in the back office and lend the use of his name to beat the law. The whole matter is one which can be well left to take care of itself. Indeed it is taking care of itself very well at the present time. There has been no serious evidence of danger or loss to the public by reason of the irresponsible performances of a wild horde of incompetent engineers. It is altogether possible that inspection would reveal more shyster lawyers and quack doctors than defective engineers, so that legislation may not be the panacea after all. Really the committee did wisely in making its recommendation, and the society did well to accept the report, and we may hope that the resurrection of the question may now be long deferred, if not omitted altogether.

## THE ENGINES OF THE GLASGOW TRAMWAYS.

### OFFICIAL DATA AND RESULTS OF IMPORTANT TRIALS OF BRITISH AND AMERICAN ENGINES IN IDENTICAL SERVICE.

*Abstract of Prof. Barr's Report.*

THE controversy which occurred about three years ago upon the question of the selection of the steam engines for the Glasgow tramway system will be remembered by engineers both in England and America, and hence the report of Professor Barr upon the tests which he has made upon the completed machinery is a matter of much interest. It will be remembered that as a result of the controversy the order for the engines was divided. There are four large engines of 4,000 horse power each, and of these two were built by Messrs. E. P. Allis & Co., of Milwaukee and two by Messrs. Musgrave & Co., of Glasgow. The general dimensions of the engines were recommended by Mr. Parshall, the consulting engineer of the company, and conformed closely to the existing practice of Messrs. Allis, but in certain particulars, notably in the diameter of the shaft, the proportions were considered excessive by British engine builders. Nevertheless Mr. Parshall's general proportions were followed by both builders, and the tests made by Professor Barr, as reported in a recent issue of *Engineering*, show the excellent results attained by both builders.

This the Allis engines gave a steam consumption of 12.2 pounds per indicated horse power per hour, while the Musgrave engines did nearly as well, namely, 13.4 pounds. The mechanical efficiency of both engines was most excellent, being about 96 per cent. in both instances.

The most interesting thing about the matter is the manner in which the proportions specified by Mr. Parshall worked out in practice. Although these were considered excessive by British engineers generally they have been shown to be none to great in practice, and as time passes it will doubtless become apparent that the large shafts and bearings will have an important influence upon the continued satisfactory operation not only of the engines but of the generators with which they are connected.

An interesting feature in connection with the contracts is the fact that the American engines were delivered a month ahead of the contract time, and, had they not been ready for work as soon as they were, there might have been no electric tramway service during the Glasgow exhibition. The Musgrave engines, although finally put into satisfactory service, encountered some preliminary difficulties which, while not important in themselves, would have delayed the service of the Corporation had the Allis engines not been ready and operative.

It would be a great mistake to construe the results of this Glasgow business into a national matter, and to use it as a comparison between British and American practice. The engineering world is growing altogether too broad to accept the same limits as those covered by political boundaries, and engineers of the better class are above such limitations. The real facts in the case are simply those which might be gathered from the results of experience. Because of the greater ease with which electric tramway privileges have been obtained in the United States, the development of electric traction has obtained a good lead there over that possible under the unfortunate restrictions in the United Kingdom. As a result a far greater degree of experience has been obtainable in America, and both Messrs. Allis and Mr. Parshall have profited thereby. The conditions differ materially from those obtaining either in marine or general stationary practice, and while it is not mantained that the American practice is necessarily the best, it has at least the benefit of greater experience, experience gained under the most severe and stringent requirements to be found anywhere.

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# LIQUID FUEL FOR STEAMSHIPS.

### PRACTICAL EXPERIENCE WITH RUSSIAN, AMERICAN, AND BORNEO PETROLEUM UNDER MARINE BOILERS—FUEL, METHODS, AND APPARATUS.

*Institution of Mechanical Engineers.*

ALTHOUGH the advantages of petroleum and its residues as a steam making fuel have long been known, there has recently appeared a great interest in the subject, partly owing to the development of new oil fields, and partly in the natural development of steam engineering. The present state of the question has been ably set forth in a paper presented before the Institution of Mechanical Engineers by Mr. E. L. Orde, of Newcastle-on-Tyne, whose previous discussion of the subject before the North East Coast Institution of Engineers and Shipbuilders we reviewed in these columns about two years ago.

Since that time the great petroleum developments of the Beaumont district in Texas have been made, while the progress in the satisfactory use of Russian fuel oil for steamships and locomotives has been most encouraging.

The present state of the supply question is discussed by Mr. Orde, who believes that commercial enterprise now only needs the stimulus of demand to organize distributing stations, while the methods of consumption on the large scale need only the attention of engineers for their development.

Mr. Orde divides the subject into four divisions: the fuel itself, the conditions governing its combustion, the apparatus employed, and the results obtained.

With the chemical composition of the

various oils the engineer is not so deeply interested as he is in the calorific value and in the behaviour during combustion. The fuel oils available for steam making are those from Borneo, Texas, Caucasus, and Burmah, the composition being in all cases about 86 per cent. carbon and 12 per cent. hydrogen, and the calorific value about 19,000 British thermal units.

Although the oil is generally used in the crude form as fuel, there are certain phenomena observed in the process of distillation which are of interest in connection with its combustion in the boiler furnace. The processes of distillation are two in number known as the "cracking process" and the steam process.

"The 'cracking' process consists in distilling over the lighter oils at temperatures above those at which they would boil under normal conditions. This is effected either by allowing the products of the distillation to condense and fall back into the contents of the still, or by distilling under pressure. The effect of the process is to decompose the heavier oils remaining in the still and materially decrease their specific gravity. The oil resulting from this process becomes more homogeneous in its composition than before; but if the temperature in the still reaches too high a point, solid carbon is deposited in the form of coke. These deposits of solid carbon, unless careful attention is paid both to the temperature to which the still is exposed and to its design, form a large proportion of the residuum after the lighter oils have been taken off; and continuous distillation on the "cracking" principle seems to be impossible owing to the rapid increase in quantity; but in the presence of steam, on the contrary, it appears to be possible to distil practically the whole of the crude product. One explanation of this phenomenon that has been given is that steam has the property of lowering the boiling points of the hydrocarbons with which it is brought in contact, and therefore allows them to volatilize at temperatures below those at which the cracking process sets in. Superheated steam is generally used in order to attain the temperature required for distillation, which reaches 550 to 600 deg. Fahr. in many cases. Air does not possess this solvent property, nor is it so convenient a vehicle for the heat required in the process of distillation. This part of the subject has been dealt with at some length, as the process of presenting the liquid fuel in boiler furnaces in the most suitable conditions for combustion is in many respects an analogous one. Before complete combustion can take place, the fuel must pass from the liquid to the vapour form; and it is obvious that the most successful apparatus must be that which accomplishes this object with the smallest expenditure of heat."

An important point in connection with the successful use of liquid fuel is the avoidance of water in the oil. The injurious action of water is twofold; it not only causes an actual loss of heat, but it interferes with the conditions necessary for perfect combustion.

Even if the amount of water present is not sufficient to extinguish the flame, it reduces the temperature and thus renders the flame longer, with the result of moving the point of highest temperature further into the furnace. This has the effect of rendering a large portion of the heating surface of the furnace useless, and of raising the temperature of the combustion chamber to a point which may injure the material, while it also causes a large part of the combustion to take place in the smoke box and funnel.

"The conditions that attend and the reactions that take place in burning liquid fuel in boiler furnaces present a problem which has apparently not received the attention which it deserves. Petroleum vapour depends entirely on temperature and it is therefore almost impossible to collect samples when actually burning it in a furnace. It seems obvious that the first effect of the furnace heat on the petroleum spray is to liberate hydrocarbon vapours, and to ignite them on the outer surface of the jet. The ignition raises the temperature of the whole of the jet, and probably dissociates some at least of the hydro-carbon vapours into carbon monoxide and hydrogen. In what form the undissociated hydrocarbon vapours burn it is difficult to conjecture, but the appearance of the flames suggests that acetylene is present. This might conceivably arise from the reaction $CH_4+CO=H_2O+C_2H_2$. As the temperature of the flame rises, the hydro-carbons are probably all dissociated and burn as CO and H to $CO_2$ and $H_2O$ without further change.

When the conditions are satisfactory, the flames are opaque and dazzling white in colour for a distance of some 6 in. from the nozzle of the burner, become semi-transparent, and almost violet in colour at the middle of their length, and shade into red at the end. In burning oil which is mixed with water the combustion is incomplete, the violet colour never appears, and the end of the flame is dark red and fringed with smoke. In some cases, where water is present in comparatively small quantities, the end of the flame is white and presents the appearance of acetylene, which may arise from want of sufficient heat in the flame to decompose the hydrocarbons. This has been observed, when, although no smoke was formed, and the air supply was not more than 20 per cent. above what is chemically necessary for the fuel, the evaporative performance of the boiler was poor, which confirms the existence of a low furnace temperature."

The burners used with liquid fuel are of three types, although many varieties have been devised. Those using a mechanical spray depend upon the pressure and form of nozzle to break up the oil into a spray sufficiently fine to render it inflammable. Jet burners use the atomizing action of a jet of steam or compressed air to deliver the fuel into the furnace in the necessary finely divided condition, while vapor burners require the fuel to be volatilized before it is admitted to the furnace in the form of vapor. The first and third types are but little used, and by far the greater number of successful burners in use are operated by means of jets of superheated steam or compressed air. In general construction these resemble the well-known Giffard injector for boiler feeding, the steam, highly superheated, driving the oil into the furnace in the best possible form for effective combustion.

In the recent experiments in the United States navy, the engineers in charge preferred the air jet, but also provided steam jets for reserve in case of failure of the air supply.

The evaporative value of fuel oil under steam boilers is naturally dependent in some measure upon the general arrangement of the apparatus, but the results of a number of tests have shown that in general the fuel consumption in favor of liquid fuel as compared with coal ranges from 25 to 35 per cent. There appears to be no doubt that the full difference between the calorific values of the two fuels can be secured in marine practice at such rates of evaporation as are usually obtained in the boilers of vessels of the merchant marine. The problem undoubtedly becomes more complex when the higher rates of evaporation, such as are required in war vessels are considered, but there is little doubt that the problem is quite within the solution of engineering skill.

The experiments in the United States navy, above referred to, brought out the important fact that practically no residue was found in the tubes of the boilers after a run from Honolulu to San Francisco. The great advantage of the maintenance of effective heating surface is well worthy of consideration, while the greater ease of firing needs only to be mentioned to be appreciated.

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# MECHANICAL APPLIANCES IN COAL MINING.

### METHODS AND MACHINERY UPON THE USE OF WHICH THE FUTURE CONTROL OF THE COAL TRADE OF GREAT BRITAIN DEPENDS.

*Paper before the Institution of Mechanical Engineers.*

Among the papers presented at the recent meeting of the Institution of Mechanical Engineers at Newcastle-on-Tyne was one by Mr. R. H. Wainford upon the employment of mechanical appliances in coal mining and in view of the importance of the subject some abstracts are here made. As Mr. Wainford truly remarks, the getting of coal is not only in itself the most important industry in the country, but it is the one upon which nearly all other great industries depend, and hence it demands the most serious consideration. For this reason the saving in the initial stage of operations in the cost of coal is a boon, not only to the mine, but to those who are dependent upon its produce.

"The advantages gained by mechanical means do not end in the simple reduction in cost of getting—there is also a substantial gain in having a coal of enhanced value, due to their being a greater percentage of round coal (not so much slack made); by there being a less number of men actually working at the coal face—the most dangerous point in a mine—and consequently a reduction in the number of claims for compensation; and another important factor, that of houses for workmen; in fact, this latter, taken in a broad sense, is capable of repaying capital outlay for plant. From this it is not to be assumed, that all men taken from the face are thrown out of work, but rather, the output of each pit is so much increased that the work of a less dangerous nature will be available for them in the pit, and an outlet will also be found in the iron and steel works, which, it is to be assumed, would have increased business, to the detriment of the imports of iron and steel, and, in fact, of general engineering work. Thus it will be gathered the introduction of mechanical appliances at the coal face does not necessarily mean paying off men, but it does suggest largely increased output, both in the mines and kindred trades. It may be urged still further—it is due to the ironworks and engineers—improved conditions in coal winning should be vigorously pushed forward. The idea of curtailing the output of coal in order that high prices may be maintained is diametrically opposed to the above suggestion—which idea represents one of the many disadvantages of piece work, and when considering mechanical methods it should be prosecuted with the ultimate intention of paying wages by the day or hour and not on tonnage."

In discussing in detail the methods and appliances used in the mechanical mining of coal, Mr. Wainford makes comparison mainly with the devices used on the Continent, although he maintains that there are doubtless machines of British manufacture equally good. Naturally the principle and immediate gain to be expected from the use of undercutting and holing machinery is the economy in labor effected, but there are other elements of saving which must be considered. Among these may be mentioned the gain due to the less amount of slack made by machine cutting over hand holing. The machines generally work under the coal, while the miner holes in the coal, the latter method naturally producing the most slack. It is found that something like 90 per cent. of the coal got by machines will pass over a ⅞ screen mesh, as against 60 per cent. by the hand method, this corresponding to an increase of 6¼d. per ton in the value of the coal. The loss from accidents is also much less with the machines than with hand working, while the gain in actual cost of working is shown to be more than 6½d. per ton, so that an advantage of more than a shilling in the ton may be had by the use of machines.

It is in the working of thin seams, however, that the gain due to cutting machines appears most conspicuously, since it is there that the cost of hand cutting is the greatest. Indeed, for seams which are more than 5 feet thick the advantage of machines is but slight, while the best results have been attained in seams of less than 2 feet thick.

Mr. Wainford describes a number of machines in his paper, these being both of the disk and bar types, the general construction and performance of which are well known. His principal contention is not the advocacy af any particular type of machine, but rather the urging of the machine as against the man, wherever possible.

"The question of determining relative results of hand work versus power is complex however, almost impossible, as singular cases would have to be taken, which, when demonstrated, will prove next to nothing. However, there is a substantial gain to be effected in this direction.

"Figures are reputed to have the quality of proving almost any set idea; if they fail, the suggestion of a local engineer might be quoted. He remarked, to prove the real value of coal-cutting and drilling machines, a number of collieries should combine together, and after selecting the most suitable type to meet each particular case, put in one cutter, with other mechanical tools to work a district; that is, each mine should set apart a district to be worked exclusively under mechanical methods, say for a year, each pit working independently, with a view to ultimately, after the expiration of the term, comparing notes and reporting results. If such a plan was possible, the idea could be effectively settled for or against, and the results would show fully the advantages which are only set down in this paper as being more than possible."

There is one point which, while not advanced by Mr. Wainford, may be not without value to mine operators, namely the greater freedom from labor difficulties when machines are used as compared with the exclusive use of hand labor. Strikes are far less likely to occur when the most difficult work can be performed by machines which may in case of emergency be operated by men more readily obtained than formerly, while the very fact that fewer men may be required must have its bearing on the frequency of labor difficulties.

Too much cannot be said on this subject of coal cutting machinery, for the all-important reason of its bearing such a serious and far-reaching effect upon the kindred to mining trades, as well as upon the prosperity and future of this country; and if real and tangible results have not been proved beyond doubt, at all events Mr. Wainford has opened out to some extent a question which must ultimately be taken up vigorously; and whatever may be the future of mechanical coal-cutters and other appliances in mines, there is the assuring fact to be remembered in considering it, that there is not a single drawback to its adaptation from the point of view of safety to life or the science of mining engineering. From the practical point of view some objections to machine practice occur; they present themselves differently in each mining district, discussion may indicate them variously. One of the chief objections to the system is the difficulty in finding men to attend the machines, possessing sufficient mechanical skill and pit experience to enable them to cope with contingencies at the face as they are met; but this hardly reflects discredit upon the mechanical methods directly. Miners con readily apply themselves if dealt with with tact and encouraged in the work. At some places machine methods have recorded a failure, traceable very often to the plant being either badly designed or lacking the necessary power, but most often to the system being taken up in a desultory manner, for it seldom happens that a new idea does not meet serious difficulties, due to prejudice, either on the part of the management or the men, or both.

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# A STUDY OF POWER GAS.

### THE GENERATION OF MOTIVE POWER IN INTERNAL-COMBUSTION ENGINES AND THE UTILIZATION OF WASTE FURNACE GASES.

*Société des Ingénieurs Civils de France.*

ABOUT three years ago there was presented before the Société des Ingénieurs Civils de France a very complete paper by the well-known expert, M. Lencauchez, upon the generation of gas suitable for direct use in internal combustion motors. At that time he considered producer gas, wood gas made by the Riché process, and water gas, and showed the greater economy attained by the use of producer gas. This paper was reviewed in these columns in the issue for September, 1899, shortly after its presentation before the Société in Paris. We now have a second paper upon the same subject, prepared by the same engineer, after the lapse of three years in which material strides have been made in the development of the subject. From this second paper by M. Lencauchez, published in the *Mémoirs de la Société Ingenieurs Civils de France,* we make some abstracts, giving a general idea of the progress which has been made in the generation of motive power direct from fuel using the product in the cylinder of the engine, without the intervention of any process of steam making.

The advantages of gaseous fuel are many, but the considerations which may lead to its adoption vary greatly with local conditions. In all cases there is a material economy from its use, since the thermal efficiency of even a small gas engine is much higher than that of the best steam engines. Questions of cleanliness, freedom from smoke, and general convenience sometime outweigh material differences in cost. In other instances the gas is a waste product from metallurgical operations, notably from blast furnaces in iron manufacture, while in others fuels altogether unsuited for steam making may be utilized in the gas producer.

In discussing the gas producer, M. Lencauchez reviews the earlier types, originally designed for the generation of gas for use in metallurgical furnaces, and then proceeds to those used for the production of power gas. While there is no fundamental difference in principle between the more recent producers and the earlier ones the improvements which have been made are important, affecting as they do both the more convenient operation of the apparatus, and in several instances, in the utilization of valuable by-products.

Originally a gas producer was simply a shaft furnace of moderate depth, in which the thickness of the fuel bed, and the limited supply of air caused but a partial combustion to take place, the result being a gaseous product consisting principally of carbonic oxide mixed with the excess of nitrogen from the air supplied for combustion. When a certain proportion of steam is blown through the incandescent fuel, a water-gas is produced, containing a varying proportion of hydrogen, and in all the varieties of fuel gas there are small amounts of hydrocarbons present, but the principal fuel elements present are carbonic oxide and hydrogen, and the calorific value of such gases range from about 100 thermal units per cubic foot for lean producer gas or waste gases from the blast furnace, to 135 thermal units for producer gas from coke, or 300 units for good water gas.

So far as thermal economy goes, it has been found that with properly constructed engines the efficiency with the very lean gas is as high, if not higher than with the richer gas, but naturally a larger engine is required to produce a given amount of power.

In the design of gas producers the principal difficulty is found in the tendency of the non-combustible portion of the fuel to form clinker, to clog or choke up the barrel of the producer. Various devices have been made to prevent this action or to render the breaking up of the clinker less difficult. In the early producers the operation of "barring" was resorted to, this consisting in the introduction of long bars through holes in the sides of the producer, and the breaking up of the obstructions by manual effort. This method, while very laborious, was also but partially effective, and frequently resulted in the formation of holes through the fuel bed through which the air passed, causing great irregularities in the production of gas. Various forms of movable and revolving grates have also been used, the aim of some of these being to keep the fuel in constant agitation, thus preventing the agglomeration of the clinker into masses. The blast furnace, while intended for altogether a different operation, solves the question of clinkering most effectively. By the use of a limestone flux, and the maintenance of a high temperature in the lower portion of a very high furnace, the noncombustible portion of the fuel, together with the non-metallic portion of the ore, is fused to a liquid slag, and drawn off before solidification, while the gas burned to carbonic acid in the lower portion of the furnace, unites with additional carbon in its passage upwards, and the ultimate gaseous product of the furnace is practically identical in composition and thermal value with that of the gas producer.

The principal questions of immediate interest in connection with the paper of M. Lencauchez are those relating to the purification of the gas from dust and the condensation and separation of the valuable by-products. In the Mond process a semi-water gas is produced, while at the same time a valuable by-product in the form of sulphate of ammonia is secured.

The removal of the dust from blast furnace gases constitutes a most important factor in their utilization directly in the cylinders of gas engines, and M. Lencauchez describes several arrangements for scrubbing and washing the gas to free it from particles which might cut or injure the cylinder. The heavier particles may be separated by a proper arrangement of flues giving opportunity for settlement, while the fine dust is removed by washing. This is best effected by passing the gas through scrubbing towers containing coke or woody fibre saturated with water from a spraying apparatus, the gas moving in the opposite direction to the water. The gas produced by different furnaces varies greatly, and in some instances no purification is necessary, since experience has shown that the very fine dust is passed through the cylinders of large engines without producing any injurious effects, either upon the piston and bore or upon the valves.

# EARTHQUAKE RECORDERS AND BRIDGE VIBRATIONS.

## THE EMPLOYMENT OF THE SEISMOGRAPH TO RECORD THE INFLUENCE OF MOVING LOADS UPON RAILWAY BRIDGES.

*Investigations of a Japanese Engineer.*

THE publications of the Imperial Earthquake Investigation Committee of Japan have been highly valued for their contributions to the study of seismology, but the latest of these publications is of especial interest to engineers because it relates to the vibrations of engineering structures rather than to the crust of the earth itself.

The very delicate instruments known as seismographs are intended to trace curves showing vibrations in any direction and thus preserve records of earthquakes too slight to be generally perceived. Various forms of construction have been used for these instruments, but the principle involved is always that of the inertia of heavy masses freely suspended, and permitting the recording surface to move beneath them with the vibrations. The delicacy of such seismometers is very great, and their use in specially maintained observatories has furnished much information as to the time, direction, and duration of earthquake shocks in various parts of the world.

Mr. F. Omori, a Japanese engineer and a member of the Imperial Earthquake Investigation Committee, has taken advantage of his familiarity with seismological instruments to use them for the study of the deflections and vibrations of railway bridges during the passage of trains, and in the publication of the Committee above referred to the results of his investigations are given at length.

As Mr. Omori remarks, such experiments furnish information of two different kinds. By taking vibration records from a number of differently constructed bridges under similar conditions, valuable comparative information may be obtained as to the best forms for strength and for economy of material. By taking a continuous series of observations of any given bridge at regular intervals, the variations in strength for various loads and for the lapse of time are recorded. Both of these results may be made of much importance, the latter, especially, might give warning of the gradual weakening of a bridge in time to prevent serious disaster.

The passage of a moving load over a bridge causes two distinct actions, although these are not always clearly separated. The mere presence of the load upon the span causes a certain bending, and if the load is permitted to remain standing in the middle of the span the amount of depression may be measured very accurately. This is called the *deflection* of the span. The action of the moving load, approaching, traversing, and leaving the span, also sets up *vibrations*, vertical, transverse, and longitudinal, the period and amplitude of these vibrations depending upon the speed with which the load moves. Hence the amount of bending observed during the passage of a train or other load is the sum of the vertical vibration and the deflection due to the dead load. The deflection can always be provided for in the original design of the bridge, and can in many cases be computed beforehand, or kept below certain prescribed limits; the vibrations are not so simply handled. Nevertheless they form a very important portion of the duty which is demanded of a bridge, and with the increase in weights and speeds every facility which is afforded for the determination of the nature and effects of vibration is to be encouraged.

Mr. Omori describes two forms of seismometer which he has used in his investigations upon Japanese bridges. One of these, the deflectometer, is similar to the vertical-motion seismograph of Gray and Ewing, modified so as to prolong its period of free oscillation, the deflection being measured as a very slow vertical vibration. The slowness of the period, being about twice the time required for the passage of the train over the bridge renders the instrument practically insensitive to the more rapid vibrations, hence it records the deflection alone.

The second instrument, the vibration measurer resembles closely a seismograph as arranged for the measurement of strong earthquakes. This is provided with horizontal pendulums as well as a vertical motion measurer, so that the movements in all three directions may be recorded. By giving the pendulums sufficient inertia and a period of oscillation altogether distinct from the possible vibrations of the bridge it is rendered easy to distinguish the real bridge vibrations from the instrumental oscillations, if there be any.

These instruments must be very rigidly attached to the bridge, preferably upon one of the bottom chords at the middle of the span, in order that the maximum effect may be noted. In Mr. Omori's paper a number of the records made by him in the course of his investigations of Japanese bridges are given, but while these are very interesting as illustrating the operation of the apparatus they are of small value as engineering data because the structures were old and of obsolete types. The general typical character of a bridge vibration, however, may be clearly deduced from the records.

The vibratory motion of a bridge consists generally of three parts: the preliminary portion, in which the motion is small and occurs with the approach of the train to the girder; this is followed by the principal portion, in which the motion is most active and generally coincides with the passage of the train or engine over the girder under experiment; after which comes the end portion, in which the motion is small, being the residual vibrations continued for a certain interval of time after the train has passed over the girder. The vertical, transverse, or longitudinal motion of a bridge girder consists in general, of the fundamental vibrations of a period which is proper to the girder itself, just as a violin string or tuning fork has its own note. Besides these there are extremely quick and usually much smaller movements, which are probably due to the vibrations of the individual members of the girder, and which may be termed micro-vibrations.

When it is realized that in nearly every case a bridge failure occurs from some other cause than excessive statical loading, it must be admitted that any method of study or research which furnishes information as to the other and powerful destructive forces in action should be welcomed. It is well known that long continued and excessive vibrations have weakening effects upon materials and structures, and the scientific and continued use of the seismograph, as indicated by Mr. Omori may lead to the determination of data by which these injurious forces may best be resisted.

## THE ELASTIC LIMIT OF METALS.

### THE APPLICATION OF OPTICAL INSPECTION TO MATERIALS UNDER TENSION AND COMPRESSION IN THE TESTING MACHINE.

*M. Ch. Fremont, in Comptes Rendus.*

IN a recent paper presented before the French Academy, and published in Comptes Rendus, M. Ch. Fremont, well-known for his experimental researches on the strength of materials, discussed the peculiar behaviour of metals under compression, considering apparent variations in the limit of elasticity.

Ordinarily the elastic limit, whether in tension or compression, is best determined from the diagram traced by some form of automatic recording device, either forming a part of the testing machine, or attached as an auxiliary apparatus, and it is generally expressed in kilogrammes per square millimetre, or pounds per square inch of the original area of cross section of the test piece. As a result of extended experience in connection with compression tests, however, Mr. Fremont has observed great variations in the elastic limit for specimens which should be practically identical. These variations can hardly be due to imperfections in the precision of the testing machines, since they appear in the work of the most carefully made apparatus, after thorough calibration and accurate adjustment.

Thus, for a steel of which the elastic limit was actually 24 kilogrammes per square millimetre, compression tests gave values of 8.55, 11.56, 13.9, 14.10, and 15.7 kilogrammes. M. Fremont suspected these variations to be due, in part at least, to the impossibility of applying the compressive force in a direct line through the test piece between the heads of the machine, the compression taking place more or less obliquely. In order to determine the manner in which the force really acted in the metal, it is only necessary to give the surface of the test piece a high polish. If the polishing is imperfectly done it will limit the observations to the appearance of deformations of greater magnitude than the inequalities in the surface, hence it is important that the metal be most highly polished. Under such conditions, when the piece is under compressive test, it is possible to observe, at the precise moment when the elastic limit is reached, a dulling of the polished surface indicating, more or less clearly, the direction of the line along which the maximum compression is being exerted. This dulling of the surface is the result of the molecular change which occurs at the moment of passing the elastic limit, and hence it appears that the limit has not been attained in those portions which retain their original polish, so that the limit of the entire specimen is not reached at one time, and a diagram obtained under such conditions cannot be considered as expressing the true resistance of the test piece. The irregular dulling of the polished surface, often in spots and discontinuous areas, while only a surface indication, may be taken as representing a corresponding irregularity in the interior of the piece. There must, therefore, exist portions of the material which are subjected to stresses below the elastic limit, while other portions of the same piece have that limit already exceeded.

Having observed these facts, M. Fremont proceeded to examine methods for the elimination of uncertainty in such an important question in connection with the resistance of materials. Assuming the inequality to be due to the difficulty in adjusting the machine so that the pressure should pass axially through the test piece, he modified the shape of the piece so that the pressure should first be localized in the axis of figure and then uniformly distributed over the whole area. This was accomplished by the use of specimens made in the form of a truncated cone or a truncated pyramid, the truncated portion being terminated in a cylinder of smaller section than the cone. The irregularities in deformation are thus localized in the weakest portion of the test piece, and from thence propagated to the polished surface for observation as before. An examination of the dulled surfaces of a polished test piece under the microscope, showed that two different types of deformation appear at the elastic limit, this being true for tests under tension as well as under compression. In the first type the deformation is effected suddenly, and there is a distinct line of demarcation between the polished and dulled portions of the surface. This is an action typical of steel. In the second type the deformation appears to occur more gradually, and the limit of the dulled portion of the surface is not indicated by a line, but fades off gradually. In the first type, successive determinations of the elastic limit of similar specimens closely approach each other, while in the second the limit can be only approximately determined.

Apart from the interest which attaches to these researches in respect to the advancement of precise testing, they serve to emphasize the importance of applying compression loads axially in practical construction, or where such axial loading is not possible, the importance of making suitable allowance for reduction in strength is indicated. Thus all the formulas and tables for the supporting strength of pillars, whether of steel, cast iron, or wood, are based upon central axial loading, a condition which is rarely, if ever, attained in actual construction. Indeed, the present practice in tall building construction, especially when cast iron columns are used, is to throw a large portion of the load upon brackets attached to the sides of the pillars in such a manner as to produce eccentric and bending loads altogether indeterminate in magnitude or direction, and invariably greater and less effectively resisted than the computations consider. If this practice is found constructively so desirable that it should be continued, the proper plan should be to subject such columns to thorough testing, not with axial loads, but with eccentric loads as similar as possible to those applied in actual practice. The information thus acquired might be used with confidence by contractors, builders, and engineers, who are now working largely in the dark as to the real strength, or weakness, of the members upon which they place such indeterminate burdens.

# EXPERIMENTAL AERONAUTICS.

## THE PROJECT FOR CROSSING THE DESERT OF SAHARA WITH A BALLOON—A MECHANICAL AUTOMATIC EXPLORING EXPEDITION.

*Experiments of the French War Department.*

FROM the original experiments of Montgolfier down to the present time the subject of aeronautics has always been popular in France, and the latest project there developed is one for the construction of a balloon to cross the desert of Sahara. This scheme includes a number of original ideas, and from an account in a recent issue of *La Revue Technique* we make some abstracts.

The idea, which is to be executed under the direction of the French War Department, is intended primarily to determine the practicability of crossing the desert in a balloon in safety, and secondarily, to secure as much information as possible about the route traversed. A number of *ballons sondés* have been sent up in France during the past few years, these being small balloons, without occupants, containing only meteorological instruments, and instructions to the finder as to the manner of reporting the arrival of the balloon at any destination.

The balloon now under construction for the Sahara trip is a repetition of these experiments on a much larger scale. It is to carry no human passengers; but in order to test the habitability of the region traversed there will be six pigeons placed in a cage in the car. An extensive equipment of scientific apparatus will be carried, and if the experiment is brought to a successful conclusion the result will be the addition of some interesting items to our stock of scientific data, and possibly an impetus may be given to future attempts on a still more ambitious scale.

The description given in *La Revue Technique* consists mainly of the specifications according to which the balloon is to be constructed and of the equipment with which it is to be supplied. The plans call for a spherical balloon, 12.4 metres in diameter (about 40 feet) made of cotton cloth, varnished, and filled with illuminating gas.

Since the balloon is to be without human passengers it is necessary that it be automatically controlled, and it is in this respect that much ingenuity has been shown in the design. As it is expected that the journey may last four or five days, provision must be made for the regulation of the ballast to provide for the gradual loss of gas. This has been done by the use of water-ballast, there being a tank containing 700 litres of water, suspended below the car in which the pigeons and the instruments are placed. In the bottom of the water tank is a valve arranged with a spring which acts to lift it open, and connected by means of a wire 12 metres in length with a steel ball of 20 kilogrammes weight. The weight of the ball is sufficient to overcome the force of the spring, and hence the valve will be kept closed so long the ball hangs freely in the air. Whenever the balloon, from loss of gas descends within 12 metres of the ground, the ball will touch and the valve being opened a portion of the water ballast will escape and the reduction in load will cause the balloon to rise and proceed.

The apparatus carried by the balloon is to consist of the usual meteorological instruments, recording barometer, thermometer, and hygrometer, etc., except that the clockwork of all of them is to be arranged to operate for five days. In addition to these there is to be carried a specially designed photographic apparatus. This camera is made somewhat on the principle of a cinematograph in that it contains a long strip film, but the photographs, instead of being taken at very close intervals, will be controlled by clockwork, an exposure being made every fifteen minutes. While doubtless many of the exposures will be worthless, there is a possibility that some very interesting pictures may be made, and the result of this portion of the expedition will be awaited with much interest.

A supply of food and water is to be provided for the pigeons, and an arrangement for their release is provided, this to come into action when the balloon itself touches the ground.

The specifications contain a detailed description of the construction of the various parts of the balloon, its suspension, inflation, and launching, as well as of the smaller balloon which is to accompany it and the 36 small paper balloons which are to be sent off at the same time, and the details of the project appear to have been very completely worked out. The balloon is to bear an inscription in French, Arabic, and English offering rewards for the safe delivery of the car and its contents.

The real value of such an experiment is difficult to determine. Doubtless there is a probability that the balloon will drift out of its course and never be heard from until, after a long interval some traces of it may be found. Assuming, however, that it does cross the desert safely, and its contents are returned to civilization, the information to be gained cannot be very great. The direction of drift must be largely depended upon transient air currents and thus give no clue as to the course of subsequent trips. The meteorological records may be of value, especially as to temperature and moisture, as well as furnishing information concerning the behaviour of recording instruments for longer periods than have hitherto been used in such experiments. As already remarked, the greatest novelty may be found in the automatic photographic apparatus, but this remains to be seen.

Even if successful, it is doubtful if such an experiment would warrant an atempt to repeat the trip with a balloon containing human passengers. Certainly if such an experiment should be made, some form of dirigible balloon should be used, and by carrying sufficient propelling power the direction of the journey might be controlled as well as the speed. The results of the experiment will be awaited with interest, even though the promised returns to science be small, and with this preliminary trial, at least, no lives are to be risked, while there is a possibility that something may be learned.

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# THE CORROSION OF PIPES BY STRAY CURRENTS.

## HOW THE DESTRUCTIVE ACTION OF THE RETURN CURRENT UPON GAS AND WATER PIPES MAY BE PREVENTED.

*A Lecture by James Swinburne.*

IT was not long after the introduction of the electric tramway that the effect of the current returned through the rail upon the gas and water pipes buried in the earth was perceived, and although there had been more or less agitation upon the subject the real merits of the question still remain open. In an interesting address recently delivered before the Incorporated Gas Institute, Mr. James Swinburne discusses the subject in a very lucid and interesting manner, and from his remarks we make some abstracts.

In the first place the character of electrolysis should be clearly understood. When an electric current passes from one metallic conductor to another through an intermediate substance, such as liquid or moist earth, there is a corrosive action set up in the metal which the current leaves, just as if the electric current carried away a part of the metal with it. This action does not occur when the current leaves through another metallic conductor, nor is there any action where it enters the second conductor.

Now in the construction of electric tramways it is the practice to take the current from the power house into the car through an overhead wire, and return it through the axle, wheels and rails back to the generators. The feeder wires are carried overhead upon insulators, but the rails are imbedded in the earth. If the rails were absolutely continuous and insulated the entire current would be returned without leakage, but the presence of joints and the absence of insulation change the conditions. Now if there should happen to be a line of gas or water pipe running along in the earth near the line of the rails, as there generally is, the current will find it easy to leave the rail in part and travel along the continuous pipe until it reaches the vicinity of the station.

The result of this action will be the corrosion of the rail at the point where the current leaves it and a corrosion of the pipe at the places where the current leaves it. Corrosion of the rails is a matter which concerns the tramway company, but it is not so injurious as the corrosion of the pipes, because the latter are soon rendered leaky, with the consequent escape of the water or gas in them. Naturally the greatest corrosion of the pipes is in the vicinity of the electric generating station, where the return current leaves the pipes to get back to the dynamos, but it is distributed along the line for a considerable distance, and in many cases it has done much harm.

Various methods have been considered to prevent this action, but none of them is altogether satisfactory. The only complete method is to provide a separate return wire, with a second trolley pole on every car, none of the current returning through the rail at all. The cost of this is considered prohibitory. It would practically throttle the tramway industry and interfere with transportation to forbid earth returns. At the same time the gas and water companies which were in existence before the tramway companies were thought of have their rights to be considered.

Naturally the first remedy to be tried is the perfecting of the electric bond between the rail joints. If this could be made continuous there would be little inducement for the current to leave the rail and seek a return through the pipes. Various plans have been tried for this purpose. Besides the various forms of flexible bonds, the rails have been electrically welded, or welded and cast by the Goldschmidt process, or joined by pouring fused iron round them from a portable cupola. When, however, the traffic is large, the increase in the return current is such that no amount of bonding will do. In such cases a negative booster has been employed. This device consists of a motor driving a generator so connected as to produce a negative pressure in the circuit, thus taking the current from the rails and returning it to the generator. Sometimes the corrosion may be reduced by connecting the gas and water pipes in the vicinity of the station with the generator by metallic connections, thus allowin the current which may be traversing them to return direct, instead of through the earth.

In spite of all these devices the fact remains that a portion of the current will stray from the rails and in its return may produce electrolytic corrosion in buried pipes to an injurious degree.

"In small towns where there is only one tramway system, the chance of appreciable electrolysis is small. In large towns there are, or soon will be, several tramway systems, and probably some electrical railways. It would be very difficult for a London company to decide who ate their pipes, and still more difficult to bring the crime home by the clumsy and expensive method of arbitration. To make the tramway people liable for any damages is obviously fair, the real difficulty is to carry the matter out. Such a liability is for that reason very serious to the tramway. A small tramway—which we will for this example suppose really innocent—is liable to be mulcted in damages that might ruin it, by a mistake of judgment of an arbitrator, or of experts called before him. This is a very serious liability.

"To sum up there is electrolysis, and your pipes are being eaten; but whether the corrosion is really serious or not can hardly be settled yet. Tramways are increasing in all directions, but they are also being more and more carefully designed. The large systems use lead-covered cables themselves, which are infinitely more easily damaged by electrolysis than gas pipes, because the lead is easily corroded, the conductors are continuous, and the cables are generally near the tramlines. The electrical tramways are thus more likely to damage themselves than their neighbors by any bad design or careless working. It behooves gas and water companies, however, to watch carefully. The question of electrolysis is not really settled. In the course of years we may have more information, and we may then find either that the stray currents are practically harmless, or that new laws have to be made."

In all the instances above noted it is assumed that the tramways are of the overhead trolley type in which the current is taken in through a trolley pole and wheel and returned through the track rails. In the underground trolley, where there are two continuous conductors in a conduit beneath the street, reached through a slot between the rails, no stray currents are to be feared, since the copper return conductor in the conduit offers a far superior return route than can be found in any water pipe.

# PRACTICAL EXPERIENCE WITH THE NERNST LAMP.

## DURATION, COST, AND ILLUMINATING EFFICIENCY OF THE NEW INCANDESCENT LAMP. THE EXPERIENCE OF USERS AND LIGHTING COMPANIES.

*Discussion of the Cincinnati Convention.*

WHEN the invention of the new incandescent lamp by Pro. Nernst was announced there were some misgivings as to the practical nature of the invention, but now that sufficient time has elapsed to enable commercial experience to be had it is possible to speak with some confidence as to its performance. There has always been a demand for some form of electric lamp which should have an illuminating power between the arc and the incandescent filament. This demand has been more or less imperfectly met by the use of incandescent lamps in clusters or by the enclosed-arc lamp, but neither of these has proved just what was wanted.

At the recent convention at Cincinnati a topical discussion was held upon the practical experience which various members had had with the Nernst lamp, and from the consensus of opinion thus obtained it appears that the new lamp bids fair to become most useful in certain fields.

It will be remembered that the invention of Professor Nernst consisted in the application of a pencil of earthy oxides as an incandescent material. The glower, as it has been termed, is a non-conductor of electricity when cold, but when heated it permits the passage of the current, at the same time opposing sufficient resistance to become heated to incandescence, and thus furnishing a brilliant light. Since the glower is composed of non-combustible materials no vacuum bulb is required to prevent its combustion, and the glower maintains its brilliancy unimpaired in the open atmosphere so long as it is heated by the passage of the current. In its practical construction the lamp has demanded much ingenuity so far as provision for preliminary heating and regulation were concerned, but these points having been met the question of practical behaviour remained.

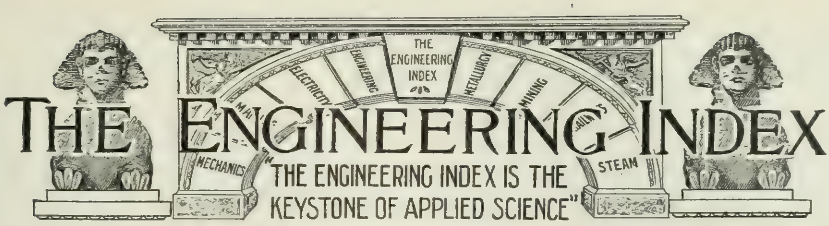
From the first the light produced by the Nernst glower has been satisfactory, resembling somewhat the illumination of the Welsbach incandescent gas mantle. The real practical questions were those of cost and durability. Although the glowers are composed of non-combustible material, yet they have a definite working life, and ultimately become disintegrated and useless. The range of this life in working practice has been from 1,300 down to 100 hours.

Usually the lamp is used with an alternating current, and with a frequency of 60 cycles the life is found to be about 800 hours, which is quite as long as can be expected from an ordinary incandescent lamp in a vacuum bulb. With a frequency of 25 cycles the life is about 400 hours, but experiments now being carried on at Niagara are expected to furnish further information on this point.

At the Cincinnati convention opinions were expressed by the representatives of a number of lighting companies, and by far the greater number of these were altogether favorable. So far as the care and attention are concerned, the amount of work closely approximates that required for the arc lamp, except that it does not have to be done so often. Every time a new glower is put in the lamp becomes practically a new one, with a maximum efficiency.

The actual efficiency of the lamp is a difficult matter for determination, but in this respect it is not greatly different from any other lamp. Until the question of the real mechanical equivalent of light is determined the mechanical efficiency of a lamp must remain an indefinite quantity. At the same time it has long been realized that the efficiency of the arc lamp is much higher than that of the incandescent filament, while for an intermediate degree of brilliancy, such as is often required, neither form of lamp has met the demand for light with a minimum consumption of current.

Experience has shown, however, that in comparison with the standard 16-candle power incandescent lamps, an equivalent degree of illumination is obtained by use of the Nernst lamp with a consumption of about 1½ watts per candle.



# THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

*We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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# CIVIL ENGINEERING

## BRIDGES.

**Arches.**

Masonry and Steel Arches on the Chicago, Milwaukee & St. Paul. Describes interesting bridge, and construction work on this line, including a masonry bridge, 360-ft. in length and a 207-ft. 3-hinged hyperbolic arch. 900 w. Ry Age—Aug. 8, 1902. No. 49943.

**Culvert.**

Design of a Concrete-Steel Arch Culvert. Daniel B. Luten. On the treatment of this material, and discussion of principles of construction. Ill. 2500 w. R R Gaz—Aug. 1, 1902. No. 49762.

**Foot-Bridge.**

Suspension Foot-Bridge, Easton, Pa. John McNeal, Jr. Brief illustrated description. 700 w. Eng Rec—Aug. 9, 1902. No. 49962.

**Girder Supports.**

Roller Bearings (Ueber Wälzungslager). Dr. Julius Mandl. An analytical discussion of the action of roller bearings under heavy pressure as in supporting the ends of bridge trusses. 3000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 19, 1902. No. 50146 B.

**Melan Arch.**

Boulder Faced Melan Arch Bridge.

National Park, Washington, D. C. W. J. Douglas. Illustrated description of a bridge of reinforced concrete construction. Specifications for the facing are given. 1600 w. Eng News—Aug. 14, 1902. No. 49983.

**Metal Arches.**

The Computations for Flat Metallic Arches (Calcul des Arcs Métalliques Surbaissés). L. de Boulougne & M. Bedaux. Deriving formulas for arches in which the rise is small compared with the span, including various conditions of loading and forms of construction. 12000 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1902. No. 50130 E+F.

**New York.**

Progress on the New East River Bridge at New York City. Report of the Commissioner of Bridges, for the six months ending June 30, 1902. 1400 w. Eng News—Aug. 21,1902. No. 50064.

**Plate-Girder.**

A Solid-Floor Single-Track Plate-Girder Bridge. Brief description of bridge on the Lake Erie & Western R. R. 800 w. Eng Rec—Aug. 16, 1902. No. 50018.

**Pontoon.**

Pontoon Foot Bridge Over the Chicago River. Illustrated description of a temporary bridge for the convenience of the people while a new bridge is being built. 500 w. Eng. News—Aug. 21, 1902. No. 50065.

**Swing Bridge.**

A Sydnev Bridge. Briefly describes the Pyrmont Bridge at Sydney, N. S. W., and its construction. The motive power is electricity. Bv simply pressing a button the bridge, weighing 800-tons, can be opened or closed in 44 seconds. 800 w. Elec Rev, N. Y—Aug. 23, 1902. No. 50054.

**Viaducts.**

Erection of the Uganda Railway Viaducts. Describes the erection of the superstructure by an overhead steel tower traveler with two 70-ft. booms which overhung the completed structure far enough to assemble a tower and two spans in advance. 1200 w. Eng Rec—Aug. 2, 1902. No. 49859.

## CANALS, RIVERS AND HARBORS.

**Canal Traction.**

Mechanical Traction on the Nivernais Canal (Canal du Nivernais—Touage Mécanique). M. Mazoyer. Illustrating the chain towing barges used on the Nivernais Canal connecting the Seine and the Loire. 3500 w. 1 plate. Ann des Ponts et Chaussées— 1 Trimestre, 1902. No. 50133 E+F.

See Electrical Engineering, Power Applications.

**Docks.**

Dock Construction in and Around Buffalo. S. M. Kielland. Briefly considers excursion docks. lumber docks, docks for rails, stone and heavy materials, ore docks, and retaining docks. 3300 w. Jour Assn of Engng Soc's—June, 1902. No. 49719 C.

**Floating Docks.**

The Great Floating Docks, of Bermuda and Algiers, La. Robert C. Fyfe. Illustrations, descriptions and comparison. 1700 w. Sci Am—Aug. 9, 1902. No. 49875.

**Floods.**

A Study of the Southern River Floods of May and June, 1901. An abstract of the report of E. W. Myers to the U. S. Geol. Survey. 4400 w. Eng News—Aug. 7, 1902. No. 49892.

**Locks.**

Submarine Concrete Foundations for the Locks at Nussdorf (Betonierung unter Wasser bei der Schleusen-Anlage in Nussdorf). F. Grohmann. A detailed account of the important foundation work of the lock chambers of the Danube Canal at Nussdorf. Serial, Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 25, 1902. No. 50144 B.

**London.**

The Port of London and the Thames. Reviews the report of the Commission appointed by the Board of Trade to inquire into the condition of this port and its navigable disadvantages, and discusses the subject generally. 3000 w. Engr, Lond—Aug. 8, 1902. Serial, 1st part. No. 50030 A.

**Manila Harbor.**

The U. S. Government Harbor Improvements and Naval Coal Storage Plant at Manila. An illustrated description of extensive work to aggregate some $2,800,000, representing the best modern practice. 3200 w. Eng News—Aug. 7, 1902. No. 49890.

**Mississippi.**

Growth of the Mississippi Delta. Warren Upham. Information of the growth and changes of the delta and mouths of this river. 3500 w. Am Geol—Aug., 1902. No. 49973 D.

**Piers.**

The Tyne North Pier Reconstruction. View and description of the work and methods of construction. 1500 w. Engng—Aug. 1, 1902. No. 49921 A.

**Rhine.**

The Regulation of the Rhine between the Vorarlberg and Switzerland (Die Rheinregulierung zwischen Vorarlberg and Schweiz). With a profile showing the slopes and the various stages of high and low water. 1500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—July 19, 1902. No. 50147 B.

**River Regulation.**

River Regulation in Upper Austria. (Die Flussregulierungs- und Wildbachverbauungs-Action in Oberoesterreich). With map showing present and proposed works, and with data as to cost of the works. 1200 w. Oesterr Wochenschr f d Oeffent Baudienst—July 26. 1902. No. 50149 B.

**St. Lawrence.**

Improving St. Lawrence River Route. Outlines the proposed improvements to facilitate navigation, better lighting, dredging, etc. 1600 w. Marine Rev—Aug. 21, 1902. No. 50210.

**Seine.**

The Navigable Seine (La Seine Maritime). L. Sekutowicz. An exhaustive discussion of the river Seine as a navigable stream from the sea, with especial reference to the port of Rouen. Four articles. I plate. 10000 w. Génie Civil—July 19, 26, Aug. 2, 9, 1902. No. 50100 each D.

**Stream Flow.**

The Form of a Course of Water with a Shifting Bed (Forme des Cours d'Eau à Fond Mobile). G. Poisson. An analytical study of the flow of water in streams, taking into account the variations in the form of cross section due to the shifting of the bed. 12000 w. 2 plates. Ann des Ponts et Chaussées—1 Trimestre, 1902. No. 50128 E+F.

## CONSTRUCTION.

**Cellar Bracing.**

Cellar Bracing in the New York Stock Exchange. This building is remarkable for the character and depth of the foundations. Some of the features of special construction used in providing bracing to resist hydraulic pressure below the groundwater line are described in this article. Ill. 3500 w. Eng Rec—Aug. 16, 1902. No. 50019.

**Cofferdam.**

Repairing a Leaky Cofferdam. Briefly describes method used at Massena, N. Y. 600 w. Eng Rec—Aug. 23, 1902. No. 50224.

**Column Bearing.**

Computations for a Ball Joint (Beitrag zur Berechnung eines Kugelgelenks). M. Marcus. A mathematical discussion of the stresses in the end of a column provided with a spherical bearing. 800 w. Schweizerische Bauzeitung—Aug. 9, 1902. No. 50123 B.

**Dams.**

The Assuan Dam and Reservoir on the River Nile. Clarence T. Johnston. Brief illustrated description, with information relating to the operation, cost, etc. 2200 w. Eng News—Aug. 14, 1902. No. 49987.

The New Croton Dam. An illustrated article describing work of interest, made necessary by the change of design, and the methods of construction. 2800 w. Eng Rec—Aug. 16, 1902. No. 50014.

The Solidification of Earth Dams (Le Corroyage des Digues en Terre). M. Galliot. Describing improved forms of rollers driven by steam, by electricity and by petrol, for the solidification of dams constructed of earth. 3500 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1902. No. 50132 E+F.

**Embankments.**

A Novel Method of Constructing High Embankments. Illustration with brief description of a temporary suspension bridge used in constructing a high embankment near Freiburg, Switzerland. 350 w. Eng News—Aug. 21, 1902. No. 50063.

**Piers.**

See Civil Engineering, Harbors.

**Simplon Tunnel.**

Observations on the Alignment of the Simplon Tunnel (Ueber einige Wahrnehmungen bie den Richtungskontrollen am Simplontunnel.) M. Rosenmund. A discussion of the operative difficulties encountered in the establishment of the line of the Simplon tunnel. 3000 w. Schweizerische Bauzeitung—Aug. 2, 1902. No. 50125 B.

The Work on the Simplon Tunnel (Die Bauarbeiten am Simplon Tunnel). H. Pflug. A general account of the work on the Simplon tunnel with a comparison with the previous tunnels through the Alps. 5000 w. Glasers Annalen—July 15, 1902. No. 50118 D.

**Tall Building.**

The Flat Iron Building, New York. Illustrations with brief description of this conspicuous New York office building. 800 w. Ir Age—Aug. 21, 1902. No. 50045.

## MATERIALS.

**Cement.**

The Chemical Analysis of Portland Cement; Its Possibilities and Its Limitations. Richard K. Meads. Read before the Am. Soc. of the International Assn. for Testing Materials. 2400 w. Eng Rec—Aug. 9, 1902. No. 49963.

**Compression.**

The Elastic Deformation of Members Subjected to Horizontal Compression (Déformation Elastique daps les Pièces Comprimées Horizontales). E. Lebert. Discussing analytically the stresses in the members of the proposed transporting bridge across the Loire at Nantes. 10000 w. Annales des Ponts et Chaussées—I Trimestre, 1902. No. 50129 E+F.

**Mortar.**

Tests of Special Properties of Mortar. Brief report of the results of extensive experiments made to determine the permeability and strength of mortars made of the natural and Portland cement mixed with varying proportions of coarse and fine sands. 700 w. Eng Rec—Aug. 16, 1902. No. 50017.

**Reinforced Concrete.**

Concrete and Melan Arches. L. K. Sherman. From a paper before the Illinois Soc. of Engrs. Concerning the computation of arches. 2000 w. Munic Engng—Aug, 1902. No. 49822 C.

The Permissible Stresses in Reinforced Concrete Construction (Ueber die Zulässige Beanspruchung der Baustoffe in Cement - Eisenconstructionen). J. E. Brik. An examination of the manner in which the elastic limit of the material is reached in the various portions of a structure. 5000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 26, 1902. No. 50148 B.

Concrete-Steel. Condensed from a paper by Prof. Brik in the *Oesterr-Wochenschr f d Oeffent Baudienst.* Gives results of experimental investigations of this material by others, and methods of computation of stresses. 4200 w. Eng Rec—Aug. 23, 1902. No. 50225.

Experiments with Reinforced Concrete (Experiences sur le Ciment Armè). M. Breuillé. Giving data and results of tests showing especially the nature and extent of the adherence of the metal to the concrete. 3500 w. Ann des Ponts et Chaussées—I Trimestre, 1902. No. 50131 E+F.

Reinforced Concrete Construction. George Hill. An illustrated description of American methods of using this material, discussing its advantages and applications and also its economy. 3300 w. Arch Rec—Sept, 1902. No. 50047 C.

Test of a Concrete Slab Reinforced with Expanded Metal. O. W. Connet. Describes method of testing a six-inch slab, and gives results. Ill. 600 w. Eng Rec—Aug. 2, 1902. No. 49860.

See Civil Engineering, Bridges.

**Timber Preserving.**

The Present Condition of Timber Preserving in the United States. Reviews the art, giving a list of the plants now running, their situation and capacity and the processes used. 1800 w. R R Gaz—Aug. 8, 1902. No. 49966.

**Uralite.**

Uralite. A material that is claimed to be made of mineral substances only; to be fire-proof and practically water-proof; to be a non-conductor of heat, cold and electricity, not affected by hot or cold water, by atmospheric influences, nor such gases as will destroy galvanized iron, is described, and some of its uses given. 2300 w. Engr, Lond—Aug. 15, 1902. No. 50088 A.

Uralite. Editorial on this material and the fire-proof tests carried out by the British Fire Prevention Committee. Describes the manufacture of the material. 2800 w. Engng—Aug. 15, 1902. No. 50096 A.

## MEASUREMENT.

**Boundary Survey.**

The Arid District Between the Rio Grande and the Pacific, Traversed by the Engineers of the Mexican Boundary Commission in 1892-94. Prof. Oscar C. S. Carter. A review and discussion of the report of the Mexican Boundary Commission. 7500 w. Pro Engrs' Club of Phila—July, 1902. No. 49722 D.

**Surveying.**

Fergusson's System of Surveying. John C. Fergusson. Describes and illustrates the use of Fergusson's surveying circle and percentage unit of angular measurement. 2800 w. Engng—July 25, 1902. No. 49796 A.

**Weight Computations.**

The Weight of Girders. H. G. Tyrrell. Gives diagrams for determining the weight of steel trusses and plate girders, with explanation of their use. 600 w. Engng—July 25, 1902. No. 49794 A.

## MUNICIPAL.

**Fire Appliances.**

"First Aid" Fire-Extinguishing Appliances. Edward George Rivers. Describes the best appliances known for quickly extinguishing fire, and remarks on the importance of their extended use. 900 w. Engng—July 25, 1902. No. 49793 A.

**Fire-Escape.**

The Schapler Fire-Escape. Illustrations, with brief description of a telescopic fire-ladder built of metal and in use in Frankfort, Germany. 1200 w. Engr, Lond—July 25, 1902. No. 49787 A.

**Garbage.**

The Garbage Disposal Problem in Boston and Elsewhere. Editorial discussion of sanitary garbage disposal. 2000 w. Eng News—Aug. 7, 1902. No. 49891.

**Pavements.**

Tar Macadam. George H. Owen. Extracts from a paper presented to the Midland Munic. Officers' Assn. Information concerning this pavement, claiming that its greater first cost is more than offset by its greater durability. 1200 w. Eng Rec—Aug. 9, 1902. No. 49964.

Vitrified Brick Pavements. William Pierson Judson. Describes the characteristics and construction of these pavements and their increasing use in the United States. 2000 w. Munic Jour & Engr—Aug., 1902. No. 49743 C.

**Sewage.**

The Present Status of the Sewage Problem in England. Prof. Leonard P. Kinnicutt. Discusses septic tanks, contact beds, and intermittent continuous filtration methods in their relation to the bacterial treatment of sewage. Discussion and illustrations. 12800 w. Jour Assn of Engng Socs—June, 1902. No. 49716. C.

**Sewage Filter.**

The Stoddart Continuous Sewage Filter. Describes a continuous filter which, it is claimed, may be worked at unusual high rates, with no devices for artificial aeration. Gives results of experience. Ill. 2800 w. Eng Rec—Aug. 23, 1902. No. 50223.

**Sewers.**

Some Details of Sewer Construction. Extracts from a paper by J. C. Meem, read before the Brooklyn Engrs' Club, giving valuable illustrated descriptions of details of sewer construction. 2000 w. Munic Engng—Aug., 1902. No. 49821 C.

## WATER SUPPLY.

**Aqueducts.**

The Loss of Capacity of the Vyrnwy Aqueduct, Liverpool, Egland. Describes the investigations which led to the discovery of a troublesome growth, and discusses means of overcoming the difficulty. 2000 w. Eng Rec—Aug. 2, 1902. No. 49858.

**Calcutta.**

The Dual Water Supply of Calcutta. Describes the two distinct systems of waterworks made necessary by local conditions. 3000 w. Eng Rec—Aug. 9, 1902. No. 49960.

**Electrolysis.**

See Street and Electric Railways, Stray Currents.

**Filtration.**

Modern Filtration. Robert E. Milligan. An explanation of the requirements of modern plants and the processes used. Ill. 1800 w. Munic Engng—Aug., 1902. No. 48-820 C.

The Slow Sand Filters of the Water-Works of Hudson, N. Y. H. K. Bishop. An illustrated account of these filter beds and their operation. They were constructed in 1874-5, and 1888 respectively. 1100 w. Eng News—Aug. 14, 1902. No. 49989.

**Pipe Coatings.**

Coatings for Cast-Iron Pipes. Thomas H. Wiggin. Read before the Boston Soc. of Civ. Engrs. Gives the results of writer's experiments in connection with the Metropolitan water-works. 3500 w. Dom Engng—Aug. 25, 1902. Serial. 1st part. No. 50211 C.

**Pressure Regulator.**

Note on Some Experiments with a New Form of Pressure Regulator. William Kendrick Hatt. Illustrates and describes apparatus for pipe lines, and records experiments made at Purdue Univ. 1200 w. Jour Fr Inst—Aug., 1902. No. 49818 D.

**Pumping Plants.**

Turbine Pumping Plants at Water-Works. Abstracts of three papers presented at meeting of the Brit. Assn. of W. Wks. Engrs., describing different turbine-driven plants at water-works. 2500 w. Jour Gas Lgt—Aug. 12, 1902. No. 50051 A.

**Purification.**

St. Louis Water Purification. Minority report of the commissioners. The plan of Allen Hazen. 3000 w. Fire & Water—Aug. 16, 1902. No. 50041.

**Rainfalls.**

Rainfalls. Alfred F. Théard. Facts concerning the local rainfall at New Orleans are given. 4200 w. Jour Assn of Engng Soc's—June, 1902. No. 49717 C.

**Rates.**

The Adjustment of Water Rates. A study of certain features of a report by Chester B. Davis to the San Antonio, Tex., Water-Works Company, which closed a controversy which had lasted eighteen months. 2000 w. Eng Rec—Aug. 9, 1902. No. 49961.

**River Pollution.**

An Important Decision Concerning River Pollution by Sewage. Condensed from decision of Ohio Supreme Court, in Balliett vs. City of Mansfield. 6400 w. Eng Rec—Aug. 16, 1902. No. 50020.

**Water-Fittings.**

Standardization of Water-Fittings. R. S. Lloyd. Extracts from a paper and discussion at the annual meeting of the Brit. Assn. of W. Wks. Engrs. Briefly reviews development and present practice, and discusses the advantages of standardization. 4800 w. Jour Gas Lgt—Aug. 5, 1902. No. 49979 A.

**Water Rights.**

The Relative Rights of Power Plant Owners and Cities to River Water. An opinion of the Ohio Supreme Court. 3300 w. Eng Rec—Aug. 9, 1902. No. 49965.

**Wells.**

The Water Supply of the Michigan Asylum for the Insane at Kalamazoo. George S. Pierson. A statement of the conditions, with illustrated description of the new well, which is connected by a siphon with the old well. 2000 w. Eng Rec—Aug. 16, 1902. No. 50015.

# ELECTRICAL ENGINEERING

## COMMUNICATION.

**Cable Testing.**

See Electrical Engineering, Measurement.

**Coherers.**

The Inherent Nature of Coherers. Edward P. Thompson. Gives experimental evidence to prove that sparks start a coherer into action. 2000 w. Elec Rev, N Y—Aug. 2, 1902. No. 49831.

**Rates.**

Telephone Rates from an Engineer's View Point. Franz J. Dommerque. Reviews the present method of charging for telephone service, outlining a scheme for charging, the kinds of rates, and the amount to be charged. 2800 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49809 D.

**Inductive Resistance.**

Improvement in Electric Transmission by Wires. Charles E. Fritts. An illustrated account of the principles involved in a method of suppressing the inductive resistances which are encountered in telegraph and telephone lines and cables. 3000 w. Elec Wld & Engr—Aug. 2, 1902. No. 49854.

**Space Telegraphy.**

Electrical Resonance and Its Relation to Syntonic Wireless Telegraphy. A. Frederick Collins. Explains the fundamental principles underlying wireless telegraphy, upon which the art of syntonic methods is based, and discusses the working out of these laws as related to syntonic wireless telegraphy. Ill. 1700 w. Sci Am—Aug. 23, 1902. Serial. 1st part. No. 50-059.

Hertzian Waves and Wireless Telegraphy. A. Frederick Collins. Gives a summary of opinions regarding the nature of the waves employed, the writer advocating the "rectilinear propagation of free waves." Also editorial notes. 4800 w. Elec Wld & Engr—Aug. 2, 1902. No. 49855.

The De Forest System of Wireless Telegraphy. An illustrated historical account of this system which is in operation between the Batterv and Staten Island, N. Y. 1600 w. Sci Am—Aug. 16, 1902. No. 49-996.

The Fessenden Wireless Telegraph Patents. A. Frederick Collins. An illustrated review of the work of Prof. Reginald A. Fessenden in the field of wireless telegraphy. 1800 w. Elec Wld & Engr—Aug. 23, 1902. No. 50221.

The Future of Wireless Telegraphy. P. T. McGrath. Gives a survey of the whole field of possible operations, noting the scientific, mechanical and competitive difficulties, its utilitarian features, and the outlook. 4200 w. N Am Rev—Aug., 1902. No. 49804 D.

The New Marconi Wireless Telegraph Station at Cape Breton. An illustrated description of the four great towers for carrying the vertical wires, to be used for transmission across the ocean. 1000 w. Sci Am—Aug. 9, 1902. No. 49876.

Wireless Telegraphy in Meteorology. Emile Guarini. An illustrated article describing observations, and apparatus used, investigating atmospheric electrical phenomena. 2500 w. Elec Wld & Engr—Aug. 2, 1902. No. 49853.

Wireless Telegraphy. Jno. Gordon Gray. Reviews the early attempts at telegraphing without wires, and the history of modern wireless telegraphy from the visit of Marconi to England in 1896, describing various methods. Discussion. 3200 w. Pro Engrs' Club of Phila.—July, 1902. No. 49723 D.

**Telegraphy.**

Delay and Output. C. H. Garland. Gives some interesting results from notes by Signor Ettore Rossi bearing upon this question. 800 w. Elect'n, Lond—July 25, 1902. No. 49779 A.

**Telephone Exchanges.**

Common Battery for Small Exchanges. S. P. Grace. Gives calculations and experiments demonstrating the feasibility and economy of transmitting sufficient battery over the toll lines to small town exchanges, and still be able to talk over the toll lines at the same time. Ill. 4000 w. Telephony—Aug., 1902. No. 49826.

The New Small Branch Exchanges of the Post-Office Telephone Service. An illustrated detailed description of one of the two completed exchanges, typical of the plan the Post-Office proposes to follow in other small branch exchanges in the neighborhood of London. 2500 w. Elect'n, Lond—July 25, 1902. Serial. 1st part. No. 49778 A.

**Telephony.**

Telephony in Australia. Interesting information from a government report, regarding the status of telephony and the proposals for the reconstruction and development of the systems of the commonwealth. 1800 w. Elec Wld & Engr—Aug. 2, 1902. No. 49852.

The Telephonic Status Quo. Arthur Vaughan Abbott. A discussion of the present situation, briefly reviewing the history and considering the outlook. 4500 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49808 D.

## DISTRIBUTION.

**Cables.**

The Utilization of Space in Cable Strands (Ueber die Raumausnutzung von Litzen). Dr. Paul Holitscher. A discussion of the twisting of cable strands so as to secure the greatest cross section in a given space. 2500 w. Elektrotech Zeitschr —July 31, 1902. No. 50165 B.

Underground Cable Laying. A. T. Stewart. Illustrates and describes various methods in use in electrical distribution. 3000 w. Elec Engr, Lond—Aug. 1, 1902. No. 49918 A.

**Circuit Breakers.**

High Tension Circuit-Safeguards. Joseph Martin Roman. An illustrated review of various controlling and safety appliances. 5000 w. Elec Wld & Engr—Aug. 16, 1902. No. 50013.

**Earthing.**

Notes re Earthing. H. Faraday Proctor. Read at the I. M. E. A. Convention. A consideration of intentional and accidental earths, and the problems arising from them. Aso discussion. 4500 w. Elec Times—July 31, 1902. No. 49903 A.

**Sparking.**

Sparking in Switches. A. Russell. Résumé of a paper communicated to the *Journal* bv the Inst. of Elec Engrs., giving results of experiments made to find a better method for the rating of switches. 1500 w. Elec Times—July 31, 1902. No. 49902 A.

**Two and Three Wires.**

The Relative Advantages of Two and Three Wire Distribution. John F. C. Snell. Read before the Incor. Munic. Elec. Assn. Compares a three-wire system with 400-volts across the outers, and a two-wire system 200-volts, discussing the relative economies. Discussion. 5800 w. Elec Engr, Lond—July 25, 1902. No. 48776 A.

## ELECTRO-CHEMISTRY.

**Batteries.**

How to Make a Dry Battery. William A. Del Mar. Instructions for making dry cells of the Burnley type. Ill. 500 w. Sci Am Sup—Aug. 2, 1902. No. 49752.

**Electro-Refining.**

The Financial Basis and Design of Electrolytic Metal Refineries. Arnold Philips. From a forthcoming work entitled "The Electro-plating and Electro-refining of Metals." Information aiming to aid in the designing of an electrolytic refinery upon a sound financial basis. Considers the establishment of an electrolytic copper refinery. 2000 w. Elect'n, Lond—Aug. 1, 1902. Serial. 1st part. No. 49920 A.

**Nitrogen.**

The Fixation of Atmospheric Nitrogen. Illustrated article regarding the producing artificially nitrates and nitric acid on a commercial scale. Also editorial comment. 2000 w. Elec Wld & Engr—Aug. 2, 1902 No. 49850.

## ELECTRO-PHYSICS.

**Alternating Currents.**

Demagnetizing Effects of Electromagnetically Compensated Alternating Currents. Zeno E. Crook. Gives methods of studying the alternating current effect on hysteresis. Ill. 2500 w. Am Jour of Sci —Aug., 1902. No. 49806 D.

**Discharge.**

The Mechanical Phenomenon of the Disruptive Discharge (Sur les Phénomenes Mécaniques de la Décharge Disruptive.) J. Semenov. Examining the conditions of the transport of material from one pole to another. 1200 w. Comptes Rendus—July 21, 1902. No. 50173 D.

**Electromagnetism.**

The Magnetic Effect of Electric Displacement, John B. Whitehead, Jr. Describes a series of experiments undertaken because of the uncertainty of the results of all effort to observe the magnetic effect, and the fact that the method employed had certain advantages over those used heretofore. Ill. 6500 w. Am Jour of Sci —Aug., 1902. No. 49805 D.

**Geissler Tubes.**

Geissler Tube and Condenser Effects. Alfred G. Dell. Gives causes of the effects observed by the writer in experimental work. 1000 w. Elec Wld & Engr —Aug. 23, 1902. No. 50220.

**Induced Currents.**

The Dissipation of Energy by Electric Currents Induced in an Iron Cylinder When Rotated in a Magnetic Field. Ernest Wilson. Read before the Royal Society. A comparison is made between the results of experiment and theory. Ill. 2000 w. Elec Engr, Lond—Aug. 15, 1902. Serial. 1st part. No. 50082 A.

**Influence Machine.**

A Large Influence Machine. H. S. Allen. An illustrated description of a large influence electrical machine, of the Wimshurst type, recently presented to the Royal Infirmary, Glasgow. 1500 w. Elec Rev, Lond—Aug. 15, 1902. No. 50085 A.

**Magnetism.**

The Real Nature of Electricity and Magnetism. Arthur A. Skeels. Gives results and conclusions from experimental investigations, discussing special cases. 3800 w. Jour Assn of Engng Soc's—June, 1902. No. 49718 C.

**Radiography.**

The Gundelach-Dessauer Röntgen Tubes (Die Gundelach-Dessauer'sche Röntgenröhre). Ludwig Henne. Describing an improved form of vacuum tube in which a regulating device is introduced. 1500 w. Elektrotech Zeitschr—July 31, 1902. No. 50166 B.

## GENERATING STATIONS.

**Alternator Construction.**

A New Frame Construction for Alternators (Ueber eine Neue Gehäusekonstruktion von Wechselstrommaschinen). H. Böhmländer. Illustrating a built-up ring of structural wrought iron, in place of the usual cast frame. 1200 w. Electrotech Zeitschr—Julv 24, 1902. No. 50162 B.

**Bogota, Columbia.**

A Modern South American Light and Power Plant. Frank C. Perkins. Brief illustrated description of the electric plant at Santa Fe de Bogota, which is 8,300 feet above the sea level, and interesting because of the difficulties in its construction and its general arrangements. 2000 w. Elec, N Y—Aug. 20, 1902. No. 50052.

**Commutation.**

Sparkless Commutation: How to Obtain It. F. W. Davies. Deals with those points in ordinary designing by attention to which it is possible to obtain good collection. 2000 w. Elec. Engr, Lond—Aug. 15, 1902. No. 50084 A.

**Düsseldorf Exposition.**

Heavy Electrical Machinery at the Düsseldorf Exposition (Die Starkstromtechnik auf der Ausstellung in Düsseldorf 1902). A. Seyfferth. A general description of the powerful generators and electrical machinery at Düsseldorf. Serial. Part I. 4000 w. Elektrotech Zeitschr—Aug. 14, 1902. No. 50169 B.

**Dynamo-Driving.**

Belt-Drives for Dynamos. W. H. Wakeman. On the location of belts, illustrating defective arrangements and showing wherein improvements could be made. 1900 w. Engr, U S A—Aug. 15, 1902. No. 50003.

**Gas Driving.**

The Romanshorn Gas Engine Driven Central Power Station. Frank C. Perkins. An illustrated description of a Swiss installation. 1100 w. Elec Rev, N Y—Aug. 9, 1902. No. 49951.

**High Pressure.**

Modern High Pressure Installations in American Cities (Moderne Hochspannungsanlagen in Amerikanischen Grossstädten). W. Blanck. Describing various generating plants and transforming stations, mainly in the business district of Chicago. Two articles, 7500 w. Elektrotechnische Zeitschr—July 31, Aug. 7, 1902. No. 50163, each B.

**Hydro-Electric Plant.**

Missouri River Power Company's 5,000-Volt Transmission Plant. A. W. Clapp. An illustrated account of improvements added to the Canon Ferry plant, and of the new sub-station at Butte. 2500 w. Elec Wld & Engr—Aug. 9, 1902. No. 49954.

The Largest Electrical Transmission of Water Power in Massachusetts. Alton D. Adams. An illustrated description of the plant at Red Bridge on the Chicopee River which is utilized by the Ludlow Manufacturing Co., four and one-half miles distant. 1700 w. Elec Wld & Engr—Aug. 16, 1902 No. 50011.

Two Recent Water-Power Plants on the Arve River, France. From *Le Genie Civil.* Describes two plants recently developed to furnish power for an electric railway running from Fayet to Chamonix. 1400 w. Eng Rec—Aug. 16, 1902. No. 50016.

**Isolated Plant.**

An Interesting Residential Electric Light and Power Plant. Illustrated description of a fine private plant at Fisher's Island, N. Y. 2500 w. Am Elect'n—Aug., 1902. No. 49885.

**Ludwigshafen.**

The Municipal Electric Plant at Ludwigshafen on Rhine (Städtisches Elektricitätswerk Ludwigshafen a. Rh.). Rudolf Gassner. With plans of the buildings and general description of the entire plant. 2000 w. Elektrotech Zeitschr—July 24, 1902. No. 50159 B.

**Newcastle-On-Tyne.**

Newcastle and District Electric Lighting Co.'s Power Stations. W. D. Hunter. Illustrates and describes the Forth Banks and Close power stations and their equipment. 8 plates. 4000 w. Inst of Mech Engrs—July 29, 1902. No. 49896 D.

The Electric-Supply Power-Station at Neptune Bank, Newcastle-Upon-Tyne. W. B. Woodhouse. An illustrated description of the first station to supply electric power in bulk in England, and also of its equipment. 2800 w. Inst of Mech Engrs—July 29, 1902. No. 49895 D.

**Power Factor.**

See Electrical Engineering, Measurement.

**Power Plants.**

See Mechanical Engineering, Steam Engineering.

**Rating.**

See Electrical Engineering, Measurement.

**Reconstruction.**

Reconstructed Central Station and Sub-Stations. Illustrated detailed description of the plant of the New York & Queens

Electric Light & Power Company. 3600 w. Am Elect'n—Aug., 1902. No. 49882.

**Winding.**

A Simple System for Armature Windings (Eine Sehr Einfache Darstellung Fortlaufender Geschlossener Wickelungen). W. Kübler. Giving a series of numerical tables for use with different kinds of windings. 1200 w. Elektrotech Zeitschr—July 17, 1902. No. 50158 B.

## LIGHTING.

**Arcs.**

The Flaming Arc Light (Ueber Flammenbogenlicht). W. Wedding. With tables of photometric data for various lengths of arcs, and for specially prepared carbons. 4500 w. Elektrotech Zeitschr—Aug. 7, 1902. No. 50168 B.

**Electroliers.**

Electric Lights for Proposed Isles of Safety in New York City. Illustrates the first and third prize designs of the Municipal Art Society of New York, with critical comment. 400 w. Eng News—Aug. 7, 1902. No. 49888.

**Illumination.**

Light and Methods of Illumination. Discussion. 7800 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49813 D.

**Lamps.**

Edison's Tungstate of Calcium Lamp. William J. Hammer. Especially discusses investigations made of the properties of radium. 3400 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49814 D.

Performance of Present 220-Volt Lamps. F. W. C. Bailey. Read at the Nat. Elec. Lgt. Assn. meeting. An account of an interesting test made, the methods and results. Diagrams. 5000 w. Cent. Station—Aug., 1902. No. 49930.

**Plymouth, Mass.**

Electric Light in the Home of the Pilgrims. Alton D. Adams. A small system which carries an important motor load is described. 1000 w. Elec Rev, N Y—Aug. 16, 1902. No. 49982.

## MEASUREMENT.

**Alternating Currents.**

An Instrument for the Determination of Alternate-Current Curves. Rudolf Goldschmidt. Translated from the *Elektrotechnische Zeitschrift*. Illustrated description of a simple instrument, explaining the principle upon which it is based. 600 w. Elec Engr, Lond—July 25, 1902. No. 49774 A.

**Cable Testing.**

The Capabilities of the Milammeter and the Galvanometer in General and Submarine Cable Testing. C. W. Schaefer. Describes the adaptability of the direct-reading milammeter to measurements of batteries, resistances, etc., and to the practical solution of many problems. 2200 w. Elect'n, Lond—Aug. 15, 1902. Serial. 1st part. No. 50080 A.

**Dynamo Tests.**

The Arc Works, Chelmsford. An account of a visit to these works to witness a Hopkinson test of two large dynamos, having an output of 800 kw. Ill. 2000 w. Elec Engr, Lond—Aug. 1, 1902. No. 49917 A.

**Meters.**

Electricity Supply Meter Tests. J. E. Dawson. Describes methods of testing meters for accuracy of registration. 1000 w. Elec Rev, Lond—July 25, 1902. No. 49777 A.

**Motor Testing.**

A Precise Brake Method for the Determination of the Efficiency of Motors (Eine Genaue Bremsmethode zur Bestimmung des Wirkungsgrades von Elektromotoren). Paul Jobst. Illustrating a convenient arrangement of electric brake, speed indicators, and volt and ammeters for motor testing. 1800 w. Elektrotech Zeitschr—July 17, 1902. No. 50157 B.

Notes on the Testing of Tramway Motors, and an Investigation into Their Characteristic Properties. Michael B. Field. Read before the Glasgow Local Sec. of the Inst. of Elec. Engrs. Shows how such motors may be tested quickly and all their characteristic properties ascertained. 3400 w. Elec Engr, Lond—Aug. 15, 1902. Serial. 1st part. No. 50081 A.

**Power Factor.**

Direct-Measurement of Wattless Power Budd Frankenfield. Explains a method devised by the writer for reading wattless power directly in a balanced three-phase circuit. Also editorial. 2500 w. Elec. Wld & Engr—Aug. 16, 1902. No. 50012.

**Rating.**

The Rating of Motors and Generators. Dr. M. G. Rasch. Read before the International Tramways Union, at Islington. A discussion of the basis that should be adopted in estimating the power. 4500 w. Elect'n, Lond—Aug. 8, 1902. No. 50028 A.

**Resistance.**

On the electrical Resistance of Glass, Quartz, Mica, Ebonite and Gutta-percha. Ogden N. Rood. Gives measurements of the external and internal resistances of certain insulating substances, describing the mode of experimenting. 1500 w. Am Jour of Sci—Aug., 1902. No. 49807 D.

**Zero Method.**

Zero Method for Magnetic Measurement (Nullmethode für Magnetische Messungen). A. Roth. Referring to the method of Goldschmidt, and describing a simple method of approximate accuracy.

1800 w. Elektrotech Zeitschr—July 24, 1902. No. 50161 B.

## POWER APPLICATIONS.

**Canal Traction.**

Results with Electric Canal Towage in Belgium. Illustrates and describes an installation on a canal between Brussels and Charleroi. 1000 w. Elec Wld & Engr—Aug. 2, 1902. No. 49851.

**Car Hoist.**

The Hoisting of Cars by an Electric Winch (Hochnehmen Vierachsiger Abtheilwagen durch Elecktrisch Angetriebene Hebeböcke). F. Bergemann. A description of the inclined plane and electrically operated winding machinery used at Eberswalde, Prussia. 2500 w. Glasers Annalen—July 15, 1902. No. 50119 D.

**Colliery Plant.**

Electric Pumping and Coal-Cutting Plant at the South Durham Colliery, near Bishop Auckland. Describes this plant recently visited by the N. of Eng. Inst. of Min. & Mech. Engrs., reporting addresses on the occasion. 2800 w. Col Guard—July 25, 1902. No. 49781 A.

Systems of Electric Power for Soft Coal Mines. John Price Jackson and William P. Cochran. Considers questions of importance in the relation of the system to be used for power operation, including haulage. Gives a description of the plant at Ehrenfeld, Pa. 2500 w. Eng & Min Jour—Aug. 16, 1902. No. 50010.

**Electric Motors.**

Some Suggestions with Regard to Electric Motor Installations. Alfred H. Mayes. Considers some of the sources of difficulty offering suggestions from practical experience in regard to the selection of the motor and accessories. 2300 w. Elec Rev, Lond—Aug. 1, 1902. No. 49919 A.

**Elevators.**

Power Consumption of Elevators Operated by Alternating and Direct-Current Motors. George F. Sever. A report of investigations made to determine the power consumption in the two different lines. Twenty tests were made by senior students in the Elec. Engng. Dept. of Columbia Univ. and the results are tabulated. 1400 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49810 D.

The Electric Elevators at the Paris Post Office (Les Montes-Charges Electriques de l'Hotel des Postes de Paris). V. Belugon. Illustrated description of the electric lifts used for handling the mail at Paris. 1500 w. 1 plate. Genie Civil—July 26, 1902. No. 50101 D.

The Power Equipment of the New Iron Elevator of the Iron Elevator and Transfer Company, Buffalo, N. Y. An illustrated description of an elevator and its equipment, in which the grain is handled by means of endless rubber belt conveyors and elevating legs which are driven by induction motors. 1100 w. Elec Rev, N Y—Aug. 9, 1902. No. 49952.

**Haulage.**

Electrical Transport of Ores. An illustrated description of the application of electricity for underground haulage. 1600 w. Aust Min Stand—June 26, 1902. Serial. 1st part. No. 49913 B.

**Induction Motors.**

A Novel Combination of Polyphase Motors for Traction Purposes. Ernst Danielson. Describes an arrangement which makes it possible to obtain economically four different speeds by means of only two motors. Ill. 4000 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49-812 D.

Polyphase Induction Motors Operating on Single Phase Circuits. A. S. M'Allister. Describes methods of operating, illustrating the mode of connecting the windings. 600 w. Am Elect'n—Aug., 1902. No. 49884.

The Influence of Closed Slots in Induction Motors (Ueber den Einfluss Geschlossener Nuthen im Inducirenden Theile von Drehstrommotoren). W. Mollier. With diagrams showing the modifications produced when the slots in the inductor are closed with iron. 2000 w. Electrotech Zeitschr—July 31, 1902. No. 50164 B.

**Mill Driving.**

Lighting and Driving Textile Mills by Electricity. Marshall Osborne. Read before the Dublin Sec. of the Inst. of Elec. Engrs. A review of what has been done in this field, and the advantages gained. 3200 w. Elec Engr, Lond—Aug. 15, 1902. No. 50083 A.

**Mining Plant.**

Electrical Equipment of the C. & C. Shaft of the Consolidated California & Virginia Mining Company. Leon M. Hall. Illustrated detailed description of this installation, which is considered one of the most complete mining installations in the world, and its operation has been entirely satisfactory. 1600 w. Eng News—Aug. 21, 1902. No. 50067.

**Motor Testing.**

See Electrical Engineering, Measurement.

**Pumping.**

Electric Pumping for Irrigation. Aug. T. Bowie, Jr. A discussion of the problems where irrigation is needed, especially where pumps not for deep wells, that are placed where all parts are readily accessible, are used. Also editorial notes. 6300 w. Elec Wld & Engr—Aug. 9, 1902. No. 49955.

**Rating.**

See Electrical Engineering, Measurement.

### TRANSMISSION.

**Lighting Arresters.**

Horn Lightning-Arresters with Iron Framing. Eugen Klein. Translated from *Elektrotechnische Zeitschrift.* Illustrates and describes these safety devices, and method of testing. 800 w. Sci Am Sup—Aug. 23, 1902. No. 50062.

**Power Plant.**

Calculation of a 50,000-Horse-Power, 80,000 Volt, 200-Mile Transmission Line. C. W. Hutton and R. Crowell. Read before the Pacific Coast Elec. Trans. Assn. Considers the proper construction and working qualities of long transmission lines from an electrical standpoint. 2200 w. Jour of Elec—July, 1902. No. 50044.

**Switzerland.**

The Transmission of Power between St. Maurice and Lausanne (Transport d'Energie de Saint-Maurice à Lausanne). A. Dumas. Describing the transmission of 5,000 horse power over a distance of 56 kilometres, by a continuous current under a pressure of 23,000 volts. 4000 w. 1 plate. Génie Civil—Aug. 2, 1902. No. 50102 D.

Transmission of Energy from St. Maurice to Lausanne, Switzerland. Enrico Bignami. Illustrates and describes an interesting plant transmitting power about 40 miles. A continuous, constant current system was adopted. Editorial comment. 2000 w. Elec Rev, N Y—Aug. 2, 1902. No. 49830.

### MISCELLANY.

**Electrical Science.**

The Old and the New Electrical Theory. Alex. P. Trotter. The object of the paper is to bring together the valuable contributions to electrical science which form a part of what is termed the "new theory." 3000 w. Elec Rev, Lond—Aug. 8, 1902. Serial. 1st part. No. 50027 A.

**Practice.**

Some Notes on Electrical Engineering Practice in Europe and America. John Denham. Read before the Cape Town Sec. of the Inst. of Elec. Engrs. On Central Station work and the transmission and utilization of electric power as observed by the writer on a recent trip through Europe and America. 6800 w. Elec Engr, Lond—Aug. 8, 1902. No. 50025 A.

## GAS WORKS ENGINEERING

**Condensation.**

Some Experiences With Condensing Plant. William Currie. Read at meeting of the N. Brit. Assn. of Gas Mgrs. Discusses the best methods, describing the plant in use by the writer and its working. 3500 w. Gas Wld—Aug. 2, 1902. No. 49916 A.

**Electrolysis.**

The Electrolysis of Gas Mains. James Swinburne. Lecture before the Incor. Gas Inst. Aims to give a broad discussion of the subject, furnishing general information. 3000 w. Elect'n, Lond—Aug. 8, 1902. Serial. 1st part. No. 50029 A.

**Fuel.**

Fuel Conditions in California. J. L. Howard. Read at meeting of the Pacific Coast Gas Assn. Reviews the past history of the fuel trade in this state and discusses the present conditions. 4000 w. Am Gas Lgt Jour—Aug. 25, 1902. No. 50215.

**Gallery Illumination.**

Lighting of Birmingham Art Gallery. Report by Professor Percy Frankland on experiments made to ascertain whether artificial illumination by electric arc lamps, or by the incandescent gas installation was preferable from the point of view of possible damage to the pictures. 2300 w. Gas Wld—July 26, 1902. No. 49770 A.

**Gas Recorder.**

See Mining and Metallurgy, Iron.

**Incandescent Lighting.**

Cause of the Rapid Dimunition in Light from Welsbach Burners. Abstract of a paper by Herr G. Wobbe, read at meeting of the Austro-Hungarian Gas Assn. Discusses how to obtain the greatest possible lighting effect. 700 w. Jour Gas Lgt—Aug. 12, 1902. No. 50050 A.

History of the Invention of Incandescent Gas-Lighting. Auer von Welsbach. An account of this valuable discovery, translated from the *Jour für Gasbeleucht und Wasservers.* 2500 w. Sci Am Sup—Aug. 2, 1902. No. 49753.

The Limit of Temperature Usefulness in the Mantle Light. Dr. W. H. Birchmore. Deductions from experimental researches concerning high temperature flames and combustion at high temperatures. 2000 w. Am Gas Lgt Jour—Aug. 18, 1902. No. 50008.

**Liquid Deposits.**

On the Liquids Deposited in the Mains and Services of a Gas Supply System. Norton H. Humphreys. Suggests the measuring of this liquid and explains the manner of doing it, and the value of the information obtained. 1200 w. Jour Gas Lgt—Aug. 5, 1902. No. 49977 A.

**Power Gas.**

The Generation of Power Gas in Producers and Blast Furnaces (Recherches sur la Production des Gaz des Gazogènes et des Haut Fourneaux). A. Lencauchez. An exhaustive examination of the production, purification and power applications of lean gas. 30,000 w. Mem Soc Ing Civ de France—June, 1902. No. 50-126 G.

**Rates.**

Gas Rates in the United States. Alton D. Adams. Information concerning production, prices, etc. 2500 w. Munic Jour & Engr—Aug., 1902. No. 49744 C.

**Retorts.**

Modern Retort House Practice. W. B. M'Lusky. Read at meeting of the N. Brit. Assn. of Gas Mgrs. On the importance of good design and good workmanship in constructing the retort house, and favoring the doing of the heavy work by mechanical means. Ill. and discussion. 4500 w. Gas Wld—July 26, 1902. No. 49769 A.

**Water Gas.**

On Some Points About the Properties and Testing of Carburetted Water Gas. Prof. C. R. C. Tichborne. Before the Irish Assn. of Gas Mgrs. Discusses the illuminating power, impurities, control of carbon monoxide, etc. 4000 w. Gas Wld—Aug. 16, 1902. No. 50077 A.

More About Methane-Hydrogen Water Gas. C. B. Tully. Read before the Irish Assn. of Gas Mgrs. Describes important features in the modified plant at Sligo, the method of working, and cost. Ill. 1800 w. Gas Wld—Aug. 16, 1902. No. 50078 A.

## INDUSTRIAL ECONOMY

**Accounting.**

Growing Necessity for Reserve Fund. A discussion of this subject in its bearing on electric railway business. 2000 w. St Ry Jour—Aug. 2, 1902. No. 49867 D.

The Utility of Reserve Accounts. A. O. Kittredge. On the wisdom of maintaining large emergency reserves in railroad business, explaining the reserve principle. 2100 w. St Ry Jour—Aug. 2, 1902. No. 49868 D.

**Arbitration.**

Arbitration or Litigation. Editorial, discussing the working of the English Arbitration Act of 1889, considering some recent cases. 3500 w. Engng—Aug. 1, 1902. No. 49925 A.

**Commerce.**

American Railroads and Our Commercial Development. Extracts from an address by George H. Daniels, before the Chautauqua Assembly, showing the achievements of American railways. 2400 w. Ry & Engng Rev—Aug. 16, 1902. No. 50006.

**Cost Accounting.**

The Electrical Tabulating Machine Applied to Cost Accounting. An illustrated article explaining the method of utilizing this machine in manufacturing establishments. 2000 w. Am Mach—July 31, 1902. No. 49728.

**Cuba.**

The Industrial Development of Cuba. Information concerning the mining and metal working industries. 1500 w. Ir Age—Aug. 14, 1902. No. 49957.

**Education.**

A Proposed Reform in Technical Training. Edward B. Raymond. The views of the writer are briefly given, advocating a strictly technical course in the training of electrical engineers. 1800 w. Trans Am Inst of Elec Engrs—May, 1902. No. 50237 D.

Electrical Engineering Courses at College and the Education of the Electrical Engineer. William Esty. Discussing electrical engineering education. 4000 w. Trans Am Inst of Elec Engrs—May, 1902. No. 50236 D.

Engineering Education. Charles H. Hines. Words of encouragement to the many who are striving to achieve success without being able to avail themselves of college or technical education, especially in the electrical field. 1500 w. Elec Wld & Engr—Aug. 23, 1902. No. 50222.

The Technical Education and Practical Training of Mechanics and Engineers. Thomas Reid. Lecture before the Dundee Inst. of Engrs. A criticism of the present system in England and outlining two courses of technical training recommended by the author. 6300 w. Mech Engr—Aug. 9, 1902. No. 50023 A.

**Exposition.**

The German Industrial Exposition at Düsseldorf. Frank C. Perkins. Illustrated description of this exhibition and some of its important engineering exhibits. 3000 w. Sci Am Sup—Aug. 2, 1902. No. 49-750.

**German Syndicates.**

The German Syndicates and Their Influence on the Recent Panic. Gives facts from various industries, and shows that Germany has a combination of syndicates for the protection of business interests. 2800 w. Ir & Coal Trds Rev—July 25, 1902. No. 49800 A.

**Intensified Production.**

Intensified Production and Industrial Investment. William D. Ennis. A discussion of the commercial factors affecting the cost of manufacturing, showing the extent to which the general policy of intensification should sometimes be modified. 3000 w. Engineering Magazine—September, 1902. No. 50186 B.

**Machinery.**

Machinery and Labor. Henry White. Address before the Am. Soc. of Pol. & Soc. Sci. Discusses the opposition of workmen to labor-saving methods, and shows the material advantages of machinery. 3200 w. Gunton's Mag—Aug., 1902. No. 49802.

**Markets.**

Future Markets for American Iron and Steel. Axel Sahlin. From the "Report on American Industrial Condition and Competition" by the British Iron Trade Association. 2200 w. Ir Age—Aug. 21, 1902. No. 50046.

**Municipal Ownership.**

Failure of Municipal Ownership in England. Hon. Robert P. Porter. Gives a brief history of the movement in England in opposition to municipal trading, as it is termed. 7500 w. St Ry Jour—Aug. 2, 1902. Serial. 1st part. No. 49866 D.

**Steel Situation.**

The Steel Situation in the United States. Editorial discussion of the present condition of the steel industry as shown by recent reports, and the need of a protective tariff. 1700 w. Engng—July 25, 1902. No. 49791 A.

**Strikes.**

The Resumption of Anthracite Mining. R. W. Raymond. A discussion of the difficulties to be met. A reply to opinions published in the *N. Y. Evening Post,* and the N. Y. *Times.* 2400 w. Eng & Min Jour—Aug. 9, 1902. No. 49947.

The South Wales Miners and the "Stop-day" Decision. Gives criticisms upon this important case by a number of leading daily journals. 4200 w. Ir & Coal Trds Rev—Aug. 15, 1902. No. 50098 A.

The Stop-Day Case. Reviews an important case between capital and labor and the decision rendered by a British court. 3000 w. Engng—Aug. 15, 1902. No. 50095 A.

**Wages.**

History of the Sliding Scale. From the *South Wales Daily News.* 1500 w. Ir & Coal Trds Rev—Aug. 8, 1902. No. 50038 A.

**Water-Power Rights.**

French Legislation on the Utilization of Water for Power. Abstract of a paper from *Le Genie Civil,* written by Charles Pinat discussing this subject. 1300 w. Eng News—Aug. 7, 1902. No. 49889.

## MARINE AND NAVAL ENGINEERING

**Battleships.**

Battleship Circular. Description of a vessel for the U. S. Navy, for which bids are invited. 2000 w. Marine Rev—July 31, 1902. No. 49828.

German First-Class Battleship Zaehringen. Describes one of a group of five sister battleships of the Wittelsbach class. Ill. 1300 w. Engr. Lond—July 25, 1902. No. 49788 A.

The Battleships "Connecticut" and "Louisiana." Illustrated detailed description of these two ships which will, when finished, be the finest of their class. 2500 w. Sci Am—Aug. 23, 1902. No. 50061.

**Bell Buoy.**

Bell Buoy That Rings Under All Conditions. Illustrated description of an improved type in use in Baltimore harbor. 1200 w. Marine Rev—Aug. 14, 1902. No. 49998.

**Belleisle Experiments.**

The Recent Belleisle Experiment. A description of experiments made (1) to ascertain the effect of lyddite on a conning tower; (2) to ascertain the effect of the same shell on torpedo nets. Ill. 3300 w. Engr, Lond—Aug. 8, 1902. No. 50033 A.

**Boilers.**

See Mechanical Engineering, Steam Engineering.

**Coal Depot.**

The Sangley Point Coaling Plant. Illustrated description of a government plant in the Philippine Islands, which includes a dredged approach, a large iron wharf, coal sheds, handling and weighing apparatus, power plant and fire service. 3000 w. Eng Rec—Aug. 9, 1902. No. 49959.

**Destroyers.**

Contract Trials of Torpedo Boat Destroyers Paul Jones, Perry and Preble. Leo Morgan. Illustrations, with description of the boats and their equipment, and report of trials. 8000 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50205 H.

**Docking.**

Docking Facilities on the Pacific Coast. William H. Crawford, Jr. Illustrations with descriptions of the new and old docks at Hunter's Point, near San Francisco, and at Mare Island Navy Yard. 1100 w. Marine Engng—Aug., 1902. No. 49739 C.

**Engines.**

See Mechanical Engineering, Steam Engineering.

**Ferryboat.**

Ferryboat Edgewater. Illustrated description of a boat recently put in service between 130th Street, N. Y., and Edgewater, N. J. 1600 w. Marine Engng—Aug., 1902. No. 49737 C.

**Lighthouse Tower.**

Steel Casing for Brick Lighthouse Tower. Illustrates and describes a method of repair and protection of a tower on Cana Island, Wisconsin. 700 w. Eng News—July 31, 1902. No. 49756.

**Lightship.**

An Automatic Lightship. Waldon Fawcett. An illustrated description of a lightship stationed at Otter Rock, off the west coast of Scotland. Its ingenious mechanical devices render its service automatic. 800 w. Sci Am—Aug. 2, 1902. No. 49749.

**Liner.**

New Anchor Liner Columbia. Diagram with brief description of a vessel, which has completed her maiden voyage. 1500 w. Marine Rev—July 31, 1902. No. 49-829.

The New German High-Speed Liner "Kaiser Wilhelm II." Begins an illustrated detailed description of this new North German Lloyd high-speed Atlantic liner, which is not only the largest ship yet built, but is to be the fastest. Also considers the type, as a passenger carrier particularly. 3800 w. Engng—Aug. 15, 1902. Serial. 1st part. No. 50089 A.

**Liquid Fuel.**

Liquid Fuel for Steamships. Edwin L. Orde. Considers the characteristics and calorific value of the various forms available, the general conditions governing its combustion, the type of apparatus for utilizing it, and the results which have been obtained. 5 plates. 4000 w. Inst of Mech Engrs—July 29, 1902. No. 49899 D.

**Material Handling.**

Handling Steel in Shipyards. Waldon Fawcett. Illustrates and describes the great cantilever cranes, and the methods of handling the heavy material in various ship yards. 2000 w. Am Mfr—Aug. 7, 1902. No. 49931.

**Naval Engineers.**

Naval Engineers. D. B. Morison, with Editorial. An important letter dealing with the question of engineering *personnel,* with editorial discussion. 5000 w. Engng—July 25, 1902. No. 49797 A.

The Doom of the British Naval Engineer. Charles M. Johnson. A discussion of the persistent official injustice to the engineers of the Royal navy, showing the disastrous results which must follow. 4000 w. Engineering Magazine—September, 1902. No. 50181 B.

The Naval Engineer of the Future. W. M. McFarland. A review of conditions in the United States navy, showing the necessity for all officers to be trained engineers. 3000 w. Engineering Magazine—September, 1902. No. 50180 B.

**Powering.**

Powering Ships. Horace Holden Thayer, Jr. Discusses two of the statements made by Durand in his work on "Resistance and Propulsion of Ships." 1100 w. Marine Engng—Aug., 1902. No. 49736 C.

**Propeller Shafts.**

See Mechanical Engineering, Measurements.

**Reconstruction.**

The Reconstructed Saale. Illustrated description of the extensive changes made in overhauling this vessel which was badly damaged by the Hoboken pier fire. 1000 w. Marine Engng—Aug., 1902. No. 49735 C.

**Shipyard.**

Messrs. Swan and Hunter's Shipyard. Illustrates and describes this interesting plant at Wallsend-on-Tyne, and the work done there. 3000 w. Engng—Aug. 8, 1902. No. 50035 A.

**Special Tools.**

Some Special Tools at the Fore River Shipyard. An illustrated description of the equipment of these works, located at Quincy, Mass. Electricity and compressed air are used throughout the plant. 2500 w. Ir Age—Aug. 7, 1902. No. 49873.

**Speed Trials.**

Notable Trials of Speed Between Early American Steamboats. J. H. Morrison. An interesting account of races previous to the year 1852, on the Hudson River, on Long Island Sound, and other waters. Ill. 4500 w. Naut Gaz—July 31, 1902. No. 49748.

**Steamboat History.**

Contributions to the History of the Invention of the Steamboat (Zur Geschichte der Erfindung des Dampfschiffs). D. H. Claus. With especial reference to the early work of Papin about 1700, also of Symington and Fulton. 5000 w. Glasers Annalen—Aug. 1, 1902. No. 50120 D.

**Steamers.**

A Review by Decades of American Deep Water Steamers in the Atlantic Coastwise Service. Ray Morris. An illustrated article showing the tendencies of traffic and of design. 6500 w. R R Gaz—Aug. 15, 1902. No. 59993.

The Stern-Wheel Steamer Alianza. Drawings and description of a steel steamer built for service in Venezuela. 700 w. Marine Engng—Aug., 1902. No. 49738 C.

**Torpedo Boats.**

Contract Trial of Torpedo Boat No. 28, the De Long. Lieut. Gustav Kaemmerling. Describes the vessel and its equipment and reports trials. 5000 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50206 H.

Submarine Torpedo Boats. G. W. Baird. Describes several designs and gives interesting information relating to them. 2500 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50207 H.

The Contract-Speed Trial of the U. S. Torpedo Boat Wilkes. Lieut. Albert Moritz. Describes the boat and its equipment and reports the trial. 3000 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50208 H.

**Tugboat.**

New Boston Tugboat. Illustrates and describes the "John G. Chandler," fitted with machinery of the most modern design and construction. 500 w. Marine Engng—Aug., 1902. No. 49741 C.

**Twin Screws.**

State Protection for Ocean Travellers. George W. Melville. Urging that all seagoing steamers shall be fitted with twin-screw engines and double bottoms, and with life-saving devices, and obliged to carry enough efficient men and officers to safely operate the vessel. Other suggestions are also given, and their economic advantages shown. 3800 w. N Am Rev —Aug., 1902. No. 49803 D.

**U. S. Navy.**

Review of the Sanitary Condition of the Navy. John C. Wise. A review showing the great changes and advances made during the last twenty years. 4000 w. San—Aug., 1902. No. 49900 D.

**Yachts.**

A Steam Yacht for Lake Service. Description and drawings of the 75-foot steel steam yacht "Louise," to be used on Lake Geneva, N. Y. 2000 w. Marine Engng—Aug., 1902. No. 49740 C.

Interior Decorations of the Helenita. Illustrated descriptions of the very fine interior of this yacht built for Frank J. Gould. 1000 w. Marine Engng—Aug., 1902. No. 49742 C.

# MECHANICAL ENGINEERING

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## AUTOMOBILES.

**Alcohol.**

Carbureted Alcohol vs. Pure Gasoline in Automobiles. Marius C. Krarup. A comparison between results obtained with carbureted alcohol in France, and with gasoline in the United States. 2000 w. Ir Age—Aug. 28, 1902. No. 50232.

**Axles.**

Axles and Springs. F. Gaillardet, in *La France Automobile.* Describes the method of manufacturing hollow axles, and discusses spring suspension in its relation to motor vehicles. 2000 w. Horseless Age—Aug. 13, 1902. No. 49976.

**Body Construction.**

Features of Body Construction in Recent Foreign Machines. Hugh D. Meier. Notes on recent improvements tending to added comfort. Ill. 1200 w. Horseless Age—July 30, 1902. No. 49727.

**Combination System.**

The Fischer Motor Vehicle Combination System. Illustrates and describes a system claiming the advantages of the electric and gasoline combined, while the disadvantages of each are practically eliminated. 900 w. Ir Age—Aug. 28, 1902. No. 50230.

**Daimler.**

1902 Type Daimler Cars. Illustrated description of vehicles embodying the latest and best practice. 3000 w. Auto Jour—July 26, 1902. Serial. 1st part. No. 49765 A.

**Endurance Run.**

Chicago Endurance Contest.—On a Rambler, No. 16. Thomas I. Stacey. An illustrated account of the run of this machine. 2500 w. Horseless Age—Aug. 13, 1902. No. 49975.

The Chicago 100 Mile Endurance Contest. An illustrated report of the contest which took place Aug. 2, 1902. 2500 w. Horseless Age—Aug. 6, 1902. No. 49872.

**Gears.**

The Packard Transmission. An illustrated description of this shifting gear transmission. 1600 w. Horseless Age—Aug. 20, 1902. No. 50053.

The Panhard Gear. Brief illustrated description of the Panhard gear. 1400 w. Autocar—Aug. 2, 1902. No. 49910 A.

**Ignition.**

Ignition Batteries. Albert L. Clough. Describes the drv batteries, discussing their troubles, methods of testing, etc. 1600 w. Horseless Age—July 23, 1902. No. 49771.

**Lubrication.**

Wrist Pin Lubrication of Vertical Engines—A Positive System. Hugh D. Meier. Describes ways of lubricating wrist pins, illustrating one device. 1400 w. Horseless Age—July 23, 1902. No. 49772.

**Lurries.**

Some Recent German Lurries. Illustrates and describes some modern heavy vehicles which present peculiarities of interest. 2000 w. Auto Jour—Aug. 9, 1902. No. 50022 A.

Steam Motor Lorry. Illustrated detailed description of a lorry built from designs of Dr. A. W. Brightmore, and of its operation. 2000 w. Engr, Lond—Aug. 8, 1902. No. 50032 A.

**Modern Uses.**

Varied Modern Uses of the Automobile. Information, with illustrations of the use of these machines for labor purposes. 1200 w. Sci Am—Aug. 9, 1902. No. 49877.

**Paris-Vienna.**

The Paris-Vienna Motor Car Races. C. R. D'Esterre. A fully illustrated account of the races, the most important ordeal yet undertaken by motor vehicles. 3000 w. Engineering Magazine—September, 1902. No. 50183 B.

**Petrol Car.**

The Chatel-Jeannin Petrol Car. An illustrated description of its construction and action. 3300 w. Auto Jour—Aug. 16, 1902. No. 50076 A.

**Races.**

The Ardennes Circuit. An illustrated account of the circular race organized by the Automobile Club of Belgium. 3000 w. Autocar—Aug. 9, 1902. No. 50021 A.

**Serpollet.**

The Latest Steam Vehicles of the Gardner-Serpollet Works, Paris (Die Neuesten Dampfwagen von Gardner & Serpollet in Paris). Max Unger. With details of the flash boiler, pumps, valve gear, etc. 3000 w. Glasers Annalen—July 15, 1902. No. 50117 D.

**Special Roadway.**

Why Not a Motor Car Way Through England? B. H. Thwaite. Suggests the construction, and describes the character of a special roadway for motor vehicles. 1500 w. Nineteenth Cent—Aug., 1902. No. 49972 D.

**Tires.**

Motor Car Tires. Discusses practical points in the manufacture of rubber tires and their repairs. 2400 w. Engr, Lond—July 25, 1902. No. 49789 A.

**Trials.**

The Welbeck Speed Trials. An illustrated article giving an account of the gathering, the vehicles, results of contests, etc. 6300 w. Auto Jour—Aug. 16, 1902. No. 50075 A.

The Welbeck Trials. An illustrated account of these trials, with results of the various contests. 3700 w. Motor Car Jour—Aug. 16, 1902. No. 50074 A.

## HYDRAULICS.

**Elevators.**

The Selection and Installation of Hydraulic Elevators. Henry D. James. Gives information relating to the proper design, construction and operation of hydraulic elevators. Ill. 3800 w. Eng News—July 31, 1902. No. 49755.

**Hydro-Electric Plants.**

See Electrical Engineering, Generating Stations.

**Ottawa.**

Water Power Development in the Vicinity of Ottawa, Ont. Shows the remarkable wealth of water power, and the applications made of it. Ill. 1400 w. Can Engr—Aug., 1902. No. 49825.

**Plumbing.**

Plumbing in the Carnegie Residence, New York. Illustrates and describes the arrangement of the piping, valves, etc, for the pump and filter supplies, the cold-water distribution and the hot-water heating supply and return. 3000 w. Eng Rec—Aug. 2, 1902. No. 49862.

**Pump.**

Mine-Draining Pump. Illustrations with description of a large pump exhibited in the mining section of the Düsseldorf exhibition. It is capable of lifting 5500 gallons per minute against a head of 1640 feet. 700 w. Engng—July 25, 1902. No. 49790 A.

See Electrical Engineering, Power Applications.

See Mining and Metallurgy, Mining.

**Sault Ste. Marie.**

New Water Power Plant at Sault Ste. Marie, Mich. An illustrated description of the plant on the American side which is expected to be in operation this autumn. 2000 w. Engr, U S A—Aug. 15, 1902. No. 50001.

**Water Power.**

Some Water Powers of New York State. An illustrated article showing what has been accomplished in developing some of the small streams and what may yet be done. 2800 w. Stone—May, 1902. No. 49985 C.

See Industrial Economy.

## MACHINE WORKS AND FOUNDRIES.

**Agricultural Machinery.**

The Manufacture of Agricultural Machinery. Joseph V. Woodworth. Illustrated description of the work as carried on by the Walter A. Wood Mowing and Reaping Machine Co. of Hoosic Falls, N.

Y. 4500 w. Mach, N Y—Aug., 1902. No. 49745.

**Boring Machine.**

Boring and Milling Machine for Connecting Rods (Bohr- und Fräsmaschine für Lenkstangen). H. Fischer. Illustrating and describing a special tool by which both ends of a rod are bored and finished at the same time. 1800 w. Zeitschr d Ver Deutscher Ing—July 19, 1902. No. 50110 D.

**Brass Founding.**

The Use of Plaster of Paris as a Brass Founders' Flux. Edwin S. Sperry, in *Aluminum World*. Concerning the theory and uses of fluxes in general, with detailed description of the flux named. 1300 w. Foundry—Aug., 1902. No. 49815.

**Castings.**

Dressing Castings. Percy Longmuir. Remarks and suggestions on the trimming of castings. 1600 w. Foundry—Aug., 1902. No. 49816.

Equilibrium of Iron-Carbon Systems. G. Charpy and L. Grenet. An illustrated account of experimental investigations, noting in particular, the results on five castings containing practically the same amount of carbon, and in which the other elements exist in small quantities, except silicon, which is in variable proportions. 1600 w. Jour Fr Inst—Aug., 1902. No. 49817 D.

Molding Bosses on Castings. John M. Richardson. Illustrated description of different methods employed. 800 w. Am Mach—Aug. 7, 1902. No. 49944.

**Cost Accounting.**

See Industrial Economy.

**Dies.**

An Automatic Combination Piercing, Bending and Twisting Die for Box Corner Fasteners. Joseph V. Woodworth. Illustrates and describes the die used, which produces these fasteners at so small a cost that they are used instead of nails or screws. 800 w. Am Mach—Aug. 7, 1902. No. 49946.

A Punch and Die for End Finishing, Cutting Off and Bending Sheet Metal from the Strip Without Waste. Also Two Dies for Metal Corner Fasteners. Joseph V. Woodworth. Illustrated description of dies and their operation. 1100 w. Am Mach—Aug. 21, 1902. No. 50057.

**Drawings.**

Standard Drawings. Warren E. Willis. Gives suggestions for drafting-room standards. 1600 w. Mach, N Y—Aug., 1902. No. 49746.

**Flasks.**

Combination Iron Flasks. R. H. Palmer. Discusses how to make flasks so that they can be easily altered to take in patterns of different styles. Ill. 1300 w. Am Mach—Aug. 7, 1902. No. 49945.

**Foundry Costs.**

The Recording and Interpreting of Foundry Costs. Percy Longmuir. A discussion of practical methods from the point of view of the manager; with numerous tables and diagrams. 2000 w. Engineering Magazine—September, 1902. No. 50185 B.

**Guards.**

Guarding Machinery Against Accidents. Illustrates and describes measures taken by a Brooklyn firm, to guard various points of danger. 700 w. Am Mach—Aug. 21, 1902. No. 50055.

**Modern Methods.**

Modern Machine Methods. H. F. L. Orcutt. Read before the Inst. of Mech. Engrs. A slightly abridged paper on machine operations, dealing with the latest practice of economical manufacture. Ill. 5300 w. Elect'n, Lond—Aug. 15, 1902. Serial. 1st part. No. 50079 A.

**Reducing Valve.**

A Large Differential Action Reducing Valve. Illustrates a reducing valve of unusual size which has found a wide variety of applications. 1400 w. Am Mach—Aug. 14, 1902. No. 40983.

**Roller Bearings.**

See Civil Engineering, Bridges.

**Screw Threads.**

The Unification of the Pitch of Screw Threads (Note Sur l'Unification des Pas de Vis). T. Payet. A discussion of the metric screw threads for gas pipe and fittings suggesting changes with a view to unification. 4000 w. Bull Soc d'Encour—July 31, 1902. No. 50137 G.

**Shop Practice.**

The Changes of a Half-Century in the Marine Engine Shop. Egbert P. Watson. An interesting account of early shop practice, and the changes which have gradually been wrought. 4000 w. Engineering Magazine—September, 1902. No. 50187 B.

**Standardization.**

Standardization in Great Britain. An editorial from the London *Times* dealing with the subject of standardization of engineering and mechanical details. 1700 w. Am Mach—July 31, 1902. No. 49730.

**Steel Works.**

The Colorado Fuel & Iron Company. An illustrated detailed description of additions and improvements to the Minnequa Works at Pueblo which will make this one of the largest steel plants in the United States. 5600 w. Ir Age—Aug. 14, 1902. No. 49956.

The Newburn Steel Works. History and description of these English works, with plan. 3000 w. Engng—Aug. 1, 1902. No. 49922 A.

The Rendsburg Steel and Rolling Mills (Das Stahl und Walzwerk Rendsburg). A full detailed description of this important North German works, with numerous illustrations. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Aug 2, 1902. No. 50113 D.

**Tempering.**

Drawing the Temper. E. R. Markham. Explains the meaning of "temper" and "tempering," and considers points relating to tool hardening. 1000 w. Am Mach—Aug. 14, 1902. No. 49984.

## MATERIALS OF CONSTRUCTION.

**Abrasives.**

Abrasive Materials in the United States. Joseph Hyde Pratt. From advance sheets of Mineral Resources of the U. S., 1901. Information concerning the natural and artificial abrasives. 2500 w. Stone—May, 1902. No. 49986 C.

**Brittleness.**

Irregularities in Fragility Tests (De la Discontinuité dans les Essais de Fragilité). H. Le Chatelier. An examination of a number of drop tests of various materials, showing the discontinuous nature of the results, and suggesting that this may be due to the methods of testing. 3000 w. Bull Soc d'Encour—July 31, 1902. No. 50136 G.

**Diseases.**

Diseases of Iron and Copper (Krankheitserscheinungen in Eisen und Kupfer). E. Heyn. A discussion of the molecular defects in iron and steel, and the methods of detecting them by physical examination. 3500 w. Zeitschr d Ver Deutscher Ing—July 26, 1902. No. 50112 D.

**Elastic Limit.**

The Determination of the Elastic Limit of Metals (Mesure de la Limite Elastique des Métaux). Ch. Fremont. An examination of the irregularities in the determination of the elastic limit of metals under compression; showing how the limit may be seen in the changes on the surface of a polished test piece. 1000 w. Comptes Rendus—Aug. 4, 1902. No. 50175 D.

## MEASUREMENT.

**Metric System.**

Lord Kelvin on the Metric System. Extracts from remarks before the Committee on Coinage, Weights and Measures of the U. S. House of Representatives, on April 24, 1902. 2800 w. Locomotive—June, 1902. No. 49801.

**Torsion Measurements.**

Recent Investigations Concerning Dynamical Action in Shafting of Marine Engines, with Special Reference to Synchronous Torsional Vibrations. Hermann Frahm. A description of the experimental plant, researches made, results and conclusions. Illustrations and diagrams. 9300 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50204 H.

## POWER AND TRANSMISSION.

**Belt Driving.**

See Electrical Engineering, Generating Stations.

**Compressed Air.**

Economy Due to Re-Heating Compressed Air. An illustrated account of experimental tests performed by W. G. Edmondson and E. L. Walker, students in the Ry. Engng. Dept. of Cornell Univ. 1500 w. Am Mach—July 31, 1902. No. 49729.

Pipes and Accessories Used in the Transmission of Power by Compressed Air. W. C. Popplewell. Discusses the sources of loss in the present article. Ill. 1800 w. Mech Engr—July 26, 1902. Serial. 1st part. No. 49768 A.

**Pneumatic Tubes.**

The Boston Pneumatic Tube Service. E. D. Sabine. Describes and illustrates the svstem for parcel delivery and its mode of operation. 1100 w. R R Gaz—Aug. 22, 1902. No. 50070.

**Shafting.**

Shafting Hints. Charles Herrman. Suggestions, with illustrations, for the installation, maintenance and repair of shafting. 3400 w. Power—Aug., 1902. No. 49732 C.

**Speed Cones.**

The Design of Speed Cones and Change Gearing. Alfred Wildgoose. Ivestigates the relation existing between any speed cone and the corresponding gearing used in conjunction with it. 2000 w. Prac Engr —July 25, 1902. No. 49766 A.

**Telpherage.**

Telpherage. Charles M. Clark. An illustrated article giving the history, construction, method of operation, applications, etc. 3800 w. Jour Assn of Engng Soc's—June, 1902. No. 49715 C.

**Variable Speed.**

Improved Variable Speed Countershaft. Illustrated description of the improved device made by the Lodge and Shipley Machine Co. of Cincinnati, Ohio. 1400 w. Am Mach—Aug. 21, 1902. No. 50056.

## SPECIAL MOTORS.

**Alcohol Motors.**

The Alcohol Motors at the Berlin Exposition, 1902 (Die Spiritusmaschinen auf der Ausstellung für Spiritusindustrie in Berlin, 1902). R. Schöttler. With details of internal combustion motors for use with methylated spirit; special reference being had to the carburetters. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 2, 1902. No. 50114 D.

See Mechanical Engineering, Automobiles.

**Explosion Motors.**

The Construction of High Speed Explosion Motors (Construction des Moteurs à Explosions et à Grande Vitesse). Louis Berger. Discussing especially the form of the cams for the operation of the valves. 2000 w. Revue Technique—Aug. 10, 1902. No. 50107 D.

**Gas Engines.**

Five-Hundred Horse-Power Gas Engine. An illustrated description of a recent type of gas engine, built for using with Mond producer gas. 900 w. Engr, Lond—Aug. 1, 1902. No. 49927 A.

Gas and Gasoline Engine Guarantees. Albert Stritmatter. A consideration of some of the things that affect what may be successfully guaranteed. 2000 w. Am Mfr—Aug. 14, 1902. No. 49974.

Lubrication of Gas Engines. J. D. Lyon. Considers troubles due to insufficient lubrication, and to excessive lubrication. 1500 w. Am Mfr—July 31, 1902. No. 49842.

See Electrical Engineering, Generating Stations.

## STEAM ENGINEERING.

**Boilers.**

Report of the British Admiralty Committee on Naval Boilers. Full report. 11-600 w. Jour Am Soc of Nav Engrs—Aug., 1902. No. 50209 H.

Safe Working Strength of Boilers. Discusses the method of determining a boiler's strength, giving rules and calculations. Ill. 2200 w. Power—Aug, 1902. No. 49-733 C.

The Stirling Marine Boiler. Illustrates and describes this boiler, stating its advantages and giving abstract of results of sea trials. 2500 w. Engr, Lond—Aug. 8, 1902. No. 50031 A.

**Boiler Supports.**

Gallows Frame Supports for Tubular Boilers. C. G. Robbins. An illustrated article discussing details of such a setting. 3700 w. Engr, U S A—Aug. 15, 1902. No. 50002.

**Condensation.**

Pumping Plant for Condensing Water. Charles Hopkinson. Describes the centrifugal pump and turbine arrangement adopted. 3 plates. 700 w. Inst of Mech Engrs—July 29, 1902. No. 49897 D.

**Engines.**

Generating Plant, Wolverhampton Exhibition. Illustrated description of a balanced high-speed steam engine representing the latest development of Bever's patent balanced engine, in which all the working parts are absolutely balanced both as regards weights and pressures. 1500 w. Engr, Lond—Aug. 1, 1902. No. 49-928 A.

Some Considerations Affecting the Economy of Marine Screw Engines. E. Hall-Brown. Read before the Brit. Inst. of Engrs & Shipbuilders. Discusses mechanical efficiency, drawing conclusions from the results of Prof. Weighton's experiments, and also other points affecting the economy. 2300 w. Naut Gaz—Aug. 21, 1902. No. 50058.

Some Experiments on Steam-Engine Economy. R. L. Weighton. Records the results of two separate and distinct sets of experiments bearing upon the economical performance of the steam-engine. 2 plates. 3000 w. Inst of Mech Engrs—July 30, 1902. No. 49898 D.

3,000 Indicated Horse-Power Vertical Triple-Expansion Engine. Illustrations and dimensions of the largest engine in the Düsseldorf exhibition. 250 w. Engng—Aug. 8, 1902. No. 50036 A.

3,000 Indicated Horse-Power Vertical Triple Expansion Engine. Illustrates and describes further interesting details of this very large engine. 900 w. Engng—Aug. 15, 1902. No. 50090 A.

**Feed-Water Filter.**

The Harris-Anderson Patent Feed-Water Filter. Illustrated description of an apparatus which it is claimed effects the removal of all oil and leaves the feed-water fit for boiler use. 1700 w. Engng—Aug. 15, 1902. No. 50091 A.

**Firing.**

Practical Hints on Firing. William Kavanagh. Suggestions for safe and economical firing and care of boilers. Ill. 1900 w. Power—Aug., 1902. No. 49734 C.

**Indicators.**

Some Indicator Hints. Forrest E. Cardullo. Illustrates and describes the styles of connection in general use, and various devices for reducing motion, giving diagrams showing faults in handling the indicator, and for troubles in the engine. 1800 w. Engr, U S A—Aug. 1, 1902. No. 49824.

**Oil Fuel.**

See Railway Engineering, Motive Power.

**Piping.**

Steam Piping (Die Dampfleitung). H. O. Ritschel. A general discussion of the proportions of steam pipes in connection with the distribution of steam from a central station for heating purposes. 4500 w. Gesundheits-Ingenieurs—July 31, 1902. No. 50156 B.

**Power Plant.**

Power Plant of the Ansonia, New York, the Largest Apartment House Ever Built. Arthur L. Rice. Illustrated detailed description of a 17-story building, containing 340 suites of apartments, besides stores, restaurants, baths, etc., especially describing the great power plant which furnishes heat, light, refrigeration, telephone service, elevator power, etc., etc. 7000 w. Engr, U S A—Aug. 1, 1902. No. 49823.

Power Plant of the Central Lard Company, Jersey City, N. J. Illustrates and describes a plant particularly interesting as regards power production and transmission. The heating is by steam, the cooling by brine, the lighting and pumping mostly by electricity, and the water supply by means of the air lift. 2000 w. Eng Rec—Aug. 9, 1902. No. 49958.

The University of Chicago Power Plant. Illustrated detailed description of a new central lighting, heating and power generating station which will meet the requirements of 25 separate buildings. 4000 w. Steam Engng—Aug. 10, 1902. No. 49999.

**Safety Valve.**

A Cause of Steam Boiler Explosions (Sur une des Causes d'Explosion des Chaudières à Vapeur). J. Fournier. Describing an improved form of inward-opening safety valve unaffected by the jet action of the escaping steam. 1200 w. Comptes Rendus—July 28, 1902. No. 50174 D.

**Speed Variations.**

The Measurement of Variations in Angular Velocity (Ueber ein Neues Verfahren zur Messung des Ungleichformigkeitsgrades und der Winkelabweichung). F. Klönne. The variations of the revolving shaft are plotted upon a uniformly revolving drum in the form of waves. 4500 w. Elektrotech Zeitschr—Aug. 14, 1902. No. 50170 B.

**Steam Turbines.**

Test of a De Laval Steam Turbine Using Superheated Steam. Details of a series of remarkable tests made by Messrs. Dean & Main, of Boston, upon a 300-brake-horse-power turbine operated at various loads and using saturated and superheated steam. 2300 w. Eng Rec—Aug. 2, 1902. No. 49857.

The DeLaval Steam Turbine (Turbine à Vapeur De Laval). K. Sosnowski. An account of the latest developments of the De Laval steam turbine, with data as to performances of recent installations. 5000 w. Revue de Mécanique—July 31, 1902. No. 50141 E+F.

The Development of the Steam Turbine. An illustrated description of the Trenton, N. J., works of the De Laval Steam Turbine Co., and an account of recent tests of a 300-brake horse-power machine. 3400 w. Elec Rev, N Y—Aug. 9, 1902. No. 49953.

**Superheated Steam.**

The Practical Economy of Using Superheated Steam. P. Nolet. Translated from the French. Discusses some of the essentials of successful application and gives reasons for the savings effected. 4000 w. Steam Engng—Aug. 10, 1902. No. 50-000.

**Tests.**

Engine Tests. H. F. Schmidt. Remarks applying to practical tests that should be frequently made by the engineer in charge. 1800 w. Am Elect'n—Aug., 1902. No. 49886.

## MISCELLANY.

**Aeronautics.**

Preliminary Project for a Dirigible Balloon (Avant-Projet de Ballon Dirigeable). M. Torres. A paper presented before the French Academy describing a spindle-shaped balloon with an interior keel. 2500 w. Comptes Rendus—July 21, 1902. No. 50172 D.

Project for a Balloon Capable of Crossing the Sahara (Projet d'Aerostats Capable de Traverser le Sahara). Leo Dex. A detailed description of a plan laid before the Minister of War for the construction of a balloon of 1,000 cubic metres capacity, for crossing the Sahara desert. 8000 w. Revue Technique—July 25, 1902. No. 50106 D.

**Aluminothermy.**

Aluminothermy (Die Aluminothermie). Dr. H. Goldschmidt. A review of the progress which has been made in the utilization of the heat of combustion of aluminum in the industrial arts. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 1, 1902. No. 50145 B.

**Heating.**

Condensing vs. Exhaust Steam Heating. Charles L. Hubbard. Discusses practical examples, assuming conditions, showing the advantages of the condenser and the obstacles. 1600 w. Am Elect'n—Aug., 1902. No. 49883.

**Lubrication.**

Force-Feed Lubricators. James F. Hobart. Brief illustrated descriptions of various lubricating devices. 2300 w. Am Elect'n—Aug., 1902. No. 49887.

**Oxygen.**

The Production of Oxygen by the Fractional Distillation of Liquid Air (Sauerstoffgewinnung mittels Fraktionierter Verdampfung Flüssiger Luft). C. Linde. Professor Linde's paper before the Society of German Engineers, giving details of the construction of his most recent apparatus. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 9, 1902. No. 50115 D.

**Refrigeration.**

An Experience with a Small Ice Machine. R. L. Shipman. Describes a defect in a small refrigerating set and the temporary and permanent remedies. Ill. 1500 w. Ice & Refrig—Aug., 1902. No. 49726 C.

A Model Western Ice Factory. Illustrated detailed description of a new plant at El Reno, Okla., and its power, distilling and freezing equipment. 2000 w. Ice & Refrig—Aug., 1902. No. 49724 C.

Recent Tests of Rrefrigerating Machines in Practical Service (Neuere Versuche an Kühlmaschine Verschiedener Systeme im Praktischen Betriebe). H. Lorenz. With tabulated data and results of a number of machines of the ammonia, sulphurous acid, and carbonic acid types. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 9, 1902. No. 50116 D.

Water Softening and Purifying Systems for Ice Plants. J. C. Wm. Greth. States the advantages of a system of water softening and purifying in ice-making, and describes the We-Fu-Go system. 1500 w. Ice & Refrig—Aug., 1902. No. 49725 C.

**Schools.**

Ventilating and Heating the Worcester, Mass., High School. Illustrated description of a system using hot water under forced circulation for warming, with air supply for ventilation only. 2000 w. Eng Rec—Aug. 23, 1902. No. 50226.

**Smoke Prevention.**

The Prevention of Smoke in Porcelain Furnaces (Rauchbelästigung durch den Betrieb von Porzellanbrennöfen). Johann Trnovsky. Discussing the especial conditions which exist in the firing of porcelain, with designs of furnaces for the prevention of smoke. 5000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 2, 1902. No. 50150 B.

**Ventilation.**

The Ventilation of Domestic Dwellings. E. W. Wagner. Read before the British Inst. of Heat & Ven. Engrs. Discusses points of importance in securing good ventilation. 3000 w. Dom Engng—Aug. 25, 1902. No. 50212 C.

# MINING AND METALLURGY

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## COAL AND COKE.

**Appliances.**

Mechanical Appliances in Mines. R. H. Wainford. Calls attention to work which may be and is done at the coal face by drills and coal-cutters, as a means of economizing. Ill. 6000 w. Inst of Mech Engrs—July 30, 1902. No. 49893 D.

**Coal Fields.**

British Columbia: Comox and Quatsino Coal Fields, Vancouver Island. William M. Brewer. Describes these fields and gives table showing the production of coal and coke of Vancouver Island, per year to date. 2000 w. Eng & Min Jour—Aug. 9, 1902. No. 49949.

The Development of the Staffordshire Coalfield. An account of the difficulties met in exploring and the final success. 2000 w. Ir & Coal Trds Rev—Aug. 8, 1902. No. 50040 A.

The Geology of the Crow's Nest Coal Areas. J. McEvoy. An illustrated article describing the formation and estimating the amount of coal in this field, etc. 4800 w. B C Min Rec—Aug., 1902. No. 49933 B.

**Coal Washing.**

Principles of Coal Washing. Samuel Dieseller. Why and to what extent classification as to sizes affects the separation of minerals of different specific gravity. 2500 w. Mines & Min—Aug., 1902. No. 49909 C.

**Connellsville.**

The Connellsville Region. Howard N. Eavenson. Read before the W. Penn. Cent. Min. Inst. Information concerning its mineral resources, various industries, all of which are overshadowed by the coke industry, its methods by mining, amount of output, etc. 5200 w. Mines & Min—Aug., 1902. No. 49908 C.

**Depreciation.**

Depreciation of Coal and Coke by Shipment. M. Stelkens. Report submitted to the International Nav. Cong. at Düsseldorf. Considers causes of deterioration, and gives some suggestions for their improvement. 3700 w. Am Gas Jour—Aug. 4, 1902. No. 49827.

**Electric Plant.**

See Electrical Engineering, Power Applications.

**Headstocks.**

The Erection of the New Headstocks at the Manners Colliery. Illustrates and describes the headstocks and the work of erection, which was accomplished expeditiously without interfering with the work of the colliery. 1700 w. Ir & Coal Trds Rev—Aug. 8, 1902. No. 50039 A.

### COPPER.

**British Columbia.**

The Ore Deposits of Copper Mountain, Similkameen District, B. C. O. N. Scott. Gives a description of these ore deposits, discussing their origin, mining and treatment. 2500 w. Can Min Rev—July 31, 1902. No. 49839 B.

**California.**

Copper in Northern California. J. S. Diller. Describes this copper region which is growing in importance. 1100 w. Min & Sci Pr—Aug. 2, 1902. Serial. 1st part. No. 49938.

**Consumption.**

Copper Consumption. Editorial concerning the consumption during the first half of the present year. 1000 w. Engng—July 25, 1902. No. 49792 A.

**Leaching.**

Some Notes on the Leaching of Oxidized Copper Ores. L. J. Charles. Reviews somewhat the history of the copper industry in the United States, the mode and place of occurrence of the ores, and the leaching. 900 w. Min Rept—Aug. 21, 1902. No. 50099.

**Ores.**

Reformed Copper Ores. J. C. Goodwin. Discusses some of the influences that country or wall rock have upon ores being deposited from the breaking down of the sulphides of copper. 800 w. Min & Sci Pr—Aug. 2, 1902. Serial. 1st part. No. 49937.

### GOLD AND SILVER.

**Appalachians.**

Gold Mining in the Southern Appalachians. Joseph Hyde Pratt. Historical review of the gold-mining industry in this region. 2000 w. Eng & Min Jour—Aug. 23, 1902. No. 50217.

**Brazil.**

Notes on Brazilian Gold Ores. Orville A. Derby. Considers certain features in the occurrence of gold. 1800 w. Eng & Min Jour—Aug. 2, 1902. No. 49845.

**Broken Hill, N. S. W.**

The Broken Hill (N. S. W.) Deposits. Discusses the correct geological classification of the lodes, and the accuracy of hypotheses advanced. 2000 w. Aust Min Stand—July 3, 1902. No. 49915 B.

**Costa Rica.**

The Gold Mines of Costa Rica. Milton Franklin Reitz. The paper aims to give a correct idea of the conservative possibilities of the mining industry in Costa Rica. Ill. 6000 w. Eng & Min Jour—Aug. 16, 1902. No. 50009.

**Honneus Process.**

De-Sulphurizing Auriferous Ore. Reports a trial of the Honneus process, made at the Great Boulder mine during the month of April. 800 w. Aust Min Stand—June 26, 1902. No. 49912 B.

**Klondike.**

The Klondike—A Four Years' Retrospect. 2000 w. B C Min Rec—Aug., 1902. No. 49935 B.

**Malay Peninsula.**

Gold Mining in Malaya. W. Broadbridge. Reports the condition of this industry which is at present under a cloud because of mismanagement. 1500 w. Aust Min Stand—July 3, 1902. No. 49914 B.

**Quartz Mining.**

The Economy of Electric Power in Quartz Mining. C. O. Poole. Read before the Pacific Coast Elec. Trans. Assn. Presents in a practical way the economical results obtained by the use of electric power in comparison with steam power, using wood, coal and oil as fuel. The paper is based on practice of the mines on the Mother Lode in Amador and Calaveras counties, California. Ill. 4800 w. Jour of Elec—July, 1902. No. 50043.

**Rossland.**

Mining in the Rossland District. C. M. Campbell. Gives briefly the history of the district, its mining practice, its geology, etc. Ill. 6400 w. Can Min Rev—July 31, 1902. No. 49841 B.

**Slimes.**

Notes on the Treatment of Slimes by Filter Presses. Clement Dixon. Briefly describes the methods used in Australia and New Zealand. 1800 w. Jour Chem & Met Soc of S Africa—June, 1902. No. 50049 E.

**Texas.**

The Silver Mine of Texas. Henry M. Adkinson. An illustrated account of the Presidio mine, reviewing its history. 1500 w. Eng & Min Jour—Aug. 2, 1902. No. 49848.

**Washington.**

The Ore Deposits of Monte Cristo, Washington. J. E. Spurr. An illustrated account of this district, the metals for which ore is especially mined are lead, copper, silver, and gold, though others are found. 1800 w. Eng & Min Jour—Aug. 23, 1902. No. 50216.

### IRON AND STEEL.

**British Columbia.**

British Columbia Iron and Coal. W. M. Brewer. A description of the various known deposits, their locations, qualities, and the extent of development. 4700 w. Mines & Min—Aug., 1902. No. 49904 C.

**Census Report.**

Census Report on Iron and Steel. Report for the census year 1900, aiming to give statistics not available for the Am. Ir & Steel Assn's annual report. 7000 w. Ir Age—Aug. 28, 1902. No. 50229.

**Gas Recorder.**

Apparatus for Recording the Gas Produced by a Blast Furnace (Registrirapparat zur Ueberwachung der Begichtung der Hochöfen). Dr. Neumark. Describing a form of recording device for indicating the rate of gas discharge from a furnace; thus giving a valuable indication of the combustion performance. 1200 w. Stahl u Eisen—Aug. 1. 1902. No. 50143 D.

**Nickel Steel.**

Nickel Steel. Much information concerning this valuable alloy, which is growing in use. Ill. 1200 w. R R Gaz—Aug. 8, 1902. No. 49967.

**Open Hearth.**

Modern Developments in the Production of Open-Hearth Steel. James Christie. Reviews the modern developments in the open-hearth process, stating the advantages claimed and the objections, and describing briefly specific processes. 3300 w. Pro Engrs' Club of Phila—July, 1902. No. 49721 D.

**Ores.**

Moisture in Lake Superior Iron Ores. N. P. Hulst. Read before the Lake Superior Mining Inst. Discusses whether it will pay to remove partially the excessive moisture before shipping. 1500 w. Ir Age—Aug. 28, 1902. No. 50233.

**Pig Iron.**

Changes in the Manufacture of Pig Iron as Illustrated by the Development of the American Blast Furnace. John Birkinbine. Reviews the history of the manufacture of iron in the United States, showing the development and progress. Illustrations and discussion. 3800 w. Pro Engrs' Club of Phila—July, 1902. No. 49720 D.

**Pyrites Mine.**

Pyrites Mine, Red Gulch Creek, Skeena Division. W. F. Best. Illustrated description of a remarkable deposit of iron pyrites. 500 w. B C Min Rec—Aug., 1902. No. 49934 B.

**Silicon.**

The Influence of Silicon upon Red Shortness (Ueber den Einfluss des Siliciums beim Glühfrischen). A. Ledebur. With tabulated data as to the effect of silicon upon the brittleness of iron at a red heat. 1500 w. Stahl u Eisen—Aug. 1, 1902. No. 50142 D.

**Steel.**

The Manufacture of Soft Center Steel. G. F. Blackiston. Describes methods of making this steel which is used for plowshares, etc. 1400 w. Ir Age—July 31, 1902. No. 49747.

**Steel Works.**

See Mechanical Engineering, Machine Works.

## MINING.

**American Methods.**

Some American Mining and Engineering Methods. The present article discusses difference between British and American methods, the American mining schools and laboratories, system of mining education, etc. Ill. 2500 w. Col Guard—Aug. 15, 1902. Serial. 1st part. No. 50086 A.

**British Columbia.**

Mineral Production of British Columbia in 1901. Statistics condensed from the annual report of the minister of mines. 600 w. U S Cons Repts, No. 1416—Aug. 12, 1902. No. 49901 D.

Mineral Resources and Mining Industry of British Columbia. William M. Brewer. A handsomely illustrated account of the district, describing the gold, copper and other ore deposits in the island sections. 3500 w. Engineering Magazine—September, 1902. No. 50182 B.

**Concentration.**

The Concentration of Ores by Means of Oil. H. E. T. Haultain. Shows the need of the process and discusses its use, considering also several processes in which oil was used. 2800 w. B C Min Rec—Aug., 1902. No. 49936 B.

**Deep Boring.**

New Methods of Deep Boring. Illustrates and describes a method which consists in the employment of the flushing water as a medium for conveying motive power to the drilling tool. 2700 w. Ir & Coal Trds Rev—Aug. 15, 1902. No. 50097 A.

**Dusseldorf Exposition.**

Mining Appliances at the Düsseldorf Exposition (Die Bergmännischen Gewinnungsarbeiten auf der Ausstellung zu Düsseldorf). H. Heise. Giving brief descriptions of various mining appliances exhibited at Düsseldorf, including boring and cutting machinery, explosives, igniters, etc. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 19, 1902. No. 50155 B.

Mining at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902). Dr. H. Hoffmann. Describing the various forms of cableways cantilevers, and other apparatus for conveying and loading ore, coal, and other mineral exhibited at Düsseldorf. 5000 w. 5 plates. Glückauf—Aug. 9, 1902. No. 50154 B.

Mining at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902). H. Fändrich. Describing especially the exhibits relating to explosives, igniting devices and safety lamps. 7500 w. 2 plates. Glückauf—July 26, 1902. No. 50152 B.

Mining at the Düsseldorf Exhibition. Remarks on the various districts giving general particulars, and calling attention to some of the objects of interest to mining engineers. 3200 w. Engr, Lond—July 25, 1902. Serial. 1st part. No. 49785 A.

Mining at the Düsseldorf Exposition (Der Bergbau auf der Düsseldorfer Ausstellung 1902). H. Herbst. Discussing the exhibits of boring and cutting machines and rock drills, with many illustrations. 7500 w. 4 plates. Glückauf—Aug. 2, 1902. No. 50153 B.

**Electric Haulage.**

See Electrical Engineering, Power Applications.

**Electric Plant.**

See Electrical Engineering, Power Applications.

**Exhibition.**

Mining Machinery at the Wolverhampton Exhibition. Illustrates and describes interesting exhibits. 1400 w. Col Guard—July 25, 1902. Serial. 1st part. No. 49783 A.

**Explosives.**

Accidents in the Use of Blasting Explosives. Remarks of H. M. Inspectors of Explosives on each class of accidents, as given in a recent report. 1700 w. Col Guard—July 25, 1902. No. 49784 A.

The Testing of Explosives for Use in Coal Mining. Information from the report of H. M. Inspector, concerning the working of the testing apparatus, the explosives that failed to pass the test, etc. 1400 w. Col Guard—Aug. 1, 1902. No. 49929 A.

**Firedamp.**

The Fernie Colliery Explosion. A discussion of this disaster at the Fernie Coal Mines in British Columbia, which occasioned the death of 130 men or more, on May 22, 1902. 2300 w. Col Guard—July 25, 1902. No. 49782 A.

The Sudden Disengagement of Firedamp (Les Dégagements Instantanés de Grisou). Henri Ghysen. A general discussion of the formation and disengagement of explosive gases in mines, with data from numerous instances in practice. 12000 w. 2 plates. Rev Univ des Mines—July, 1902. No. 50134 H.

**Haulage.**

Different Methods of Mine Haulage Compared. B. F. Jones. Considers the good and bad methods found as parts of all systems. Ill. 7000 w. Mines & Min—Aug., 1902. No. 49906 C.

**Mexico.**

Through the Sierra Madres in Chihuahua, Mexico. George D. James. An account of the mining camps, description of the country, and general information. Ill. 3800 w. Eng & Min Jour—Aug. 2, 1902. No. 49844.

**Power Drills.**

Power Drills. C. C. Hansen. An illustrated description of some of the better known types. 1700 w. Can Min Rev—July 31, 1902. No. 49838 B.

**Prospecting.**

Hints to Prospectors. W. J. Adams. Showing that deposits of value are often overlooked, and urging the saving of unknown crystals, with data of their locality. 1200 w. Min & Sci Pr—Aug. 2, 1902. No. 49939.

**Pumps.**

Cornish Pumps. Prof. W. R. Crane. Considers their construction and method of operation as illustrated in the Galena-Joplin District, Missouri. Ill. 2500 w. Mines & Min—Aug., 1902. No. 49907 C.

**Quarries.**

Karlshäll Granite Quarries, Carlshamn, Sweden. An illustrated detailed description of this famous granite district. 4600 w. Quarry—Aug., 1902. No. 49980 A.

**Shaft Sinking.**

The Application of Suspended Steam-Pumps to the Sinking of Deep Shafts. W. Price Abell. An illustrated article endeavoring to show the advantages when suitable pumps, tackle, winches, etc., are used. 1800 w. Ir & Coal Trds Rev—July 25, 1902. No. 49799 A.

The Sinking of Shafts in Water Bearing Strata (Les Creusements de Puits en Morts-Terrains). A. Habets. Discussing especially the devices for sinking shafts shown at the Düsseldorf exposition including the methods of Tomson, Sassenberg and Clermont, and Pattberg. 8000 w. 3 plates. Rev Univ des Mines—July, 1902. No. 50135 H.

**Timbering.**

Mine Timbering in the Old Ironsides and Knob Hill Mines. H. P. De Pencier. An illustrated description of extensive timbering made necessary by the immense size of the ore bodies. 3500 w. Can Min Rev—July 31, 1902. No. 49840 B.

Square Sett Timbering. T. O. Renowden. Describes the timbering of the Ophir mine, U. S. A., and at Broken Hill, N. S. W. 1500 w. Aust Min Stand—June 19, 1902. No. 49911 B.

**Winding Engines.**

Electrically-Driven Winding Engines. Illustrated description of an engine for a Dortmund mining company which will haul from a depth of 2,296 feet, 100 tons of coal per hour. Also of another type to be used in Saxony, which hauls in a ten hours' shift, from 600 to 700 tons of coal from a depth of 722 feet. 1500 w. Engng—Aug. 1, 1902. No. 49923 A.

Electrically Operated Hoisting Plants (Förderanlagen mit Elektrischem Antrieb). O. Lasche. With detailed illustrations of several hoists, showing the wiring, and method of control. 2500 w. 1 plate. Glückauf—July 19, 1902. No. 50151B.

Double Tandem Winding Engine (Zwillings-Tandem-Fördermaschine). A. Deeg. A detailed description of the new winding engine with double spiral drums recently built for the coal mines at Rouchamp, France, by the Humboldt Machine Works at Kalk. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 19, 1902. No. 50108 D.

### MISCELLANY.

**Aluminum.**

Process for Extracting Aluminum. Describes the process and gives information regarding the production, values, consumption, etc. 1200 w. Am Mfr—July 31, 1902. No. 49843.

**Asbestos.**

Mining Asbestos in Canada. W. Mollman. States the principal localities giving information concerning the methods of mining, appliances used, treatment, etc. 900 w. Min & Sci Pr—July 26, 1902. No. 49835.

**California.**

Mineral Production of California for 1901. Report of the state mineralogist, with much information of interest. 2000 w. Eng & Min Jour—Aug. 9, 1902. No. 49950.

**Cuba.**

See Industrial Economy.

**Diamonds.**

Diamonds and Carbons in Bahia. Information concerning the deposits, method of mining, labor conditions, state regulations, method of selling, etc. 4300 w. U S Cons Repts, No. 1423—Aug. 20, 1902. No. 50042 D.

**Manganese.**

A New Departure in Manganese Mining. J. S. C. Wells. Describes the washing out of the ore by hydraulic methods, similar to those used for gold. 500 w. Eng & Min Jour—Aug. 2, 1902. No. 49-846.

The Manganese Deposits of Santiago Province, Cuba. Arthur C. Spencer. Gives the location of deposits thus far worked, describing the ores, mode of occurrence, geology, etc. Ill. 2300 w. Eng & Min Jour—Aug. 23, 1902. No. 50218.

**Petroleum.**

Oil in Book Cliff Region of Colorado. A description of the formations near Rifle Creek, showing oil signs. 2400 w. Mines & Min—Aug., 1902. No. 49905 C.

The Beaumont Oil Field, with Notes on Other Oil Fields of the Texas Region. Robert T. Hill. Gives much information concerning the occurrences of oil, describes the geology of the Texas region, etc. Ill. 5000 w. Jour Fr Inst—Aug., 1902. Serial. 1st part. No. 49-819 D.

The Fort Steele Oil Field. J. C. Kennedy. A preliminary report giving information of the oil-bearing rocks of Wyoming. 1600 w. Min Rept—Aug. 7, 1902. No. 49932.

**Platinum.**

Microscopic Effects of Stress on Platinum. Thomas Andrews and Charles Reginald Andrews. Experiments are described, with illustrations, showing the behavior of this metal. 800 w. Engng—July 25, 1902. No. 49795 A.

**Tin.**

Red River Tin Stream, Cornwall. Edward Skewes. An illustrated article discussing the mode of operation of the these English tin mines, the loss of tin, etc. 2900 w. Eng & Min—Aug. 9, 1902. No. 49948.

## RAILWAY ENGINEERING

### CONDUCTING TRANSPORTATION.

**Accidents.**

Government Accident Bulletin Number 3. The report of the Interstate Commerce Commission summarizing the collisions, derailments and casualites during the three months ending March 31. 1500 w. R R Gaz—Aug. 1, 1902. No. 49761.

Train Accidents in the United States in June. Classified list. 2500 w. R R Gaz—Aug. 1, 1902. No. 49760.

**Collisions.**

Forty-one Rear Collisions. Editorial discussing the Government reports, Bulletins No. 2 and No. 3, and the causes of the collisions. 1500 w. R R Gaz—Aug. 22, 1902. No. 50071.

**Fast Run.**

A Twentieth Century Run. An account of a run of 133.9 miles at 69.3 miles per hour, to make up time lost by the tracks being blocked by a wreck. 800 w. Am

Engr & R R Jour—Aug., 1902. No. 49833 C.

**Per Diem.**

A Question to be Decided in Connection with Per Diem Agreements. Editorial discussion of the question where state laws grant to shippers a specific number of days for loading and unloading. 1700 w. R R Gaz—Aug. 15, 1902. No. 49994.

**Switzerland.**

Statistics of Swiss Railways (Aus der Schweizerischen Eisenbahnstatistik). With comparative tables, showing the development of Swiss railways in 1898, 1899, and 1900. 2500 w. Schweizerische Bauzeitung—July 10, 1902. No. 50122 B.

**Train Service.**

Birmingham to London in One Hour, Fifty-five Minutes. Describes the successful run of a new train on the London and North Western. 800 w. Engr, Lond—Aug. 8, 1902. No. 50034 A.

## FINANCIAL.

**Purchase.**

The Eastern Illinois Purchase. Editorial discussion of the purchase of the Chicago & Eastern Illinois R. R. by the St. Louis & San Francisco R. R. Co. 2000 w. R R Gaz—Aug. 15, 1902. No. 49995.

## MOTIVE POWER AND EQUIPMENT.

**Car Lighting.**

Car Lighting by Acetylene and Electricity. Extracts from the address of L. T. Canfield before the M. C. B. Association at Saratoga. 1500 w. Am Engr & R R Jour—Aug., 1902. No. 49834 C.

**Cars.**

A New Method of Steel Car Construction. Plan and elevation drawings, with detail views of a design of car which is the invention of H. C. Hodges. The claim is that a lighter, cheaper, simpler steel frame car is shown which will compare favorably in strength with any of the present forms. 1400 w. Ry & Engng Rev—Aug. 2, 1902. No. 49836.

New Vestibule Coaches on the C. R. R. of N. J. Very handsome coaches are illustrated and described. 400 w. Loc Engng Aug., 1902. No. 49881 C.

The Constructive Features of the Goodwin Car. John M. Goodwin. Describes the special features of this car. 1600 w. R R Gaz—Aug. 8, 1902. No. 49968.

Unique Design for Combined Sleeping and Parlor Car. Brief description of the Holland patent, which gives a compartment sleeping car for night service, and an open parlor car for day travel, with partitions that can be easily operated. 700 w. Ry & Engng Rev—Aug. 16, 1902. No. 50005.

**Instruction Car.**

Air Brake Instruction Car on the N. Y. C. & H. R. R. R. Illustrations showing details of construction and the general interior arrangement, with description. 700 w. Ry & Engng Rev—Aug. 9, 1902. No. 49941.

**Locomotives.**

Canadian Ten-Wheeler. Illustration and principal dimensions of a passenger engine designed to haul transcontinental trains. 900 w. Loc Engng—Aug., 1902. No. 49880 C.

Four-Wheel Coupled Three-Cylinder Compound Locomotive. Illustrated description of an engine for passenger service on the Midland Railway, England. 800 w. Engng—Aug. 15, 1902. No. 50093 A.

Metre-Gauge Locomotive. Drawings, photographs and description of a 12-wheel coupled compound duplex tank locomotive designed and built on the Mallet system. 500 w. Engng—Aug. 1, 1902. No. 49924 A.

Metre-Gauge Fairlie Engines for the Burma Railway Company. Illustrates and describes the most modern form of these engines. 2200 w. Sci Am Sup—Aug. 16, 1902. No. 49997.

New Six-Coupled Passenger Locomotive. Illustration and general dimensions of a design for the Missouri Pacific Railway. 800 w. Am Engr & R R Jour—Aug., 1902. No. 49832 C.

Passenger Engines for the Chesapeake & Ohio and the Missouri Pacific. Illustrates and describes the notable features of two engines, giving general description. 600 w. R R Gaz—Aug. 1, 1902. No. 49759.

Recent Progress in Locomotive Construction (Neuere Fortschritte im Lokomotivbau). H. v. Borries. A review of the recent developments in locomotive work, including superheating, compounding, improved materials, etc. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—July 19, 1902. No. 50109 D.

Six-Wheel Connected Passenger Locomotive for the C. & O. Ry. Illustrated description of mountain type passenger engines for fast service under exacting conditions. 900 w. Ry & Engng Rev—Aug. 2, 1902. No. 49837.

Ten-Wheel Passenger Locomotives for the Mexican National Ry. Illustrations with description of recently completed engines designed for burning bituminous coal. 1000 w. Ry & Engng Rev—Aug. 23, 1902. No. 50214.

The Distribution of Work in Compound Locomotives (Répartition du Travail dans les Machines Compound). G. Mohr. An examination of the steam distribution in compound locomotives for various positions of the link. 1000 w. Génie Civil—Aug. 2, 1902. No. 50103 D.

The First Successful Coal Burner and Its Modern Successor. Two illustrations, with an account of the introduction of coal for locomotive fuel. 1100 w. Loc Engng—Aug., 1902. No. 49879 C.

**Oil Fuel.**

The Application of Masut on the Russian Railways (Application du Mazout au Chauffage des Locomotives Russes). H. Guérin. Describing the apparatus used for burning the petroleum residues of Southeastern Russia. 1200 w. Génie Civil—Aug. 9, 1902. No. 50105 D.

**Rolling Stock.**

New Rolling Stock, Midland Great-Western Railway of Ireland. Describes new rolling-stock, giving illustrations of new locomotives. 1200 w. Engr, Lond—July 25, 1902. No. 49786 A.

**Valve Gear.**

A New Valve Gear for Compound Locomotives (Neue Steuerung für Verbundlokomotiven). M. Kuhn. With diagrams of an improved form of straight-link motion, and indicator cards showing the steam distribution. 3000 w. Zeitschr d Ver Deutscher Ing—July 26, 1902. No. 50111 D.

**Valves**

The Application of Cylindrical Steam Distributing Valves to Locomotives. Walter M. Smith. Gives illustrated descriptions of valves tried, and much information concerning the working of engines fitted with them, their action under different conditions, etc. Ill. 6000 w. Inst of Mech Engrs—July 30, 1902. No. 49894 D.

**Weight Distribution.**

A Diagram for Axle Loading and Its Application to Locomotives (Das Diagramm der Achsbelastung und Seine Anwendung bei Drei und Mehrachsigen Lokomotiven). J. Kempf. A graphical and analytical examination of the distribution of weights in locomotives by means of equalizing levers. 1200 w. Glasers Annalen—Aug. 1, 1002. No. 50121 D.

### NEW PROJECTS.

**Africa.**

The Cape to Cairo Railway. An interesting account of the progress and present condition of this railway, the rolling stock, business, etc. 1200 w. Engr, Lond—Aug. 1, 1902. Serial. 1st part. No. 49926 A.

**Bagdad.**

The Bagdad Railroad. D. G. Hogarth. Extract from an article in the *National Review,* London. giving the history of this project. 1800 w. R R Gaz—Aug. 8, 1902. No. 49972.

**Ecuador.**

The Guayaquil & Quito Railway of Ecuador. An illustrated historical account of this interesting piece of railway construction, with information concerning elevation and the character and number of bridge structures. 1500 w. Ry Age—Aug. 8, 1902. No. 49942.

**Mountain Railway.**

The Lötschberg Railway (Die Lötschbergbahn). An account of the topography and route of the proposed railway and tunnel, over the Lötschberg, Switzerland. The tunnel will be 8½ miles long. Serial. Part I. 2000 w. Schweizerische Bauzeitung—Aug. 9, 1902. No. 50124 B.

**Salt Lake.**

The Railroad Through Salt Lake. Illustrations and description of novel methods used in the construction of the Ogden-Lucin cut-off of the Southern Pacific. The present article deals with the construction in shallow water. 1300 w. Ry Age—Aug. 15, 1902. No. 50004.

### PERMANENT WAY AND FIXTURES.

**Car Hoist.**

See Electrical Engineering, Power Applications.

**Engine-House.**

B. & O. Standard Engine-House and Machine Shop, at Fairmont, W. Va. Illustrated detailed description. 600 w. R R Gaz—Aug. 1, 1902. No. 49758.

**Frost Action.**

Disturbance of Roadbed and Bridges by Frost on the Trans-Siberian Railway. Illustrated description of interesting phenomena observed on this line in Siberia. 500 w. Eng News—July 31, 1902. No. 49754.

**Power Plant.**

The Power Plant of the New Union Station. D. B. Kinch. Describes the power plant of the new station of the Pennsylvania R. R. at Pittsburg, Pa. 3000 w. Pro Engrs Soc of W Penn—July, 1902. No. 50202 D.

**Re-building.**

The Re-building of the Baltimore & Ohio Railroad. Gives an outline of the general scheme, and an illustrated account of the proposed reconstruction work. 4000 w. R R Gaz—Aug. 22, 1902. No. 50068.

**Shops.**

The Omaha Railway Shops at Saint Paul. An illustrated description of the extensive improvements made in the St. Paul shops to furnish better facilities for rolling-stock maintenance. 1600 w. Ry Age—Aug. 22, 1902. No. 50213.

**Signalling.**

A Description of the Westinghouse Electro-Pneumatic Interlock Switch and

Signal System Installed in the Yards of the Pennsylvania Union Station, Pittsburg, Penna., by the Union Switch and Signal Company. J. G. Schreuder. Ill. 5000 w. Pro Egrs Soc of W Penn—July, 1892. No. 50203 D.

A New Safety Signal System for Repeating Railway Danger Signals Visibly and Audibly in the Locomotive Cab. From *La Nature.* Illustrates and describes an invention of Capt. Netter, the object of which is to reproduce in the engineer's cab the signals seen along the track. 1800 w. Sci Am Sup—Aug. 2, 1902. No. 49751.

Electric Interlocking at Bridge Junction. Illustrates and describes a plant in Illinois having features of particular interest, one of the switches being a mile from the cabin. 1200 w. R R Gaz—Aug. 15, 1902. No. 49992.

Fog Signaling. A study of ten accidents on British railways due to fogs, and how to prevent the ignoring of danger signals. Shows the difficulties to be overcome. 2400 w. Engr, Lond—Aug. 15, 1902. No. 50087 A.

Interlocking Switch Towers (Cabines d'Enclenchements). M. Cossmann. A discussion of the arrangement of the tower for a number of levers as illustrated by the station at Amiens, and elsewhere in France. 3500 w. Rev Gen d Chemins de Fer—Aug., 1902. No. 50139 H.

Modern Electric Block Signaling. E. F. Bliss. Abstract of a thesis presented for graduation at the Univ. of Nebraska. Outlines some of the more important features of present automatic block-signal practice. Ill. 4800 w. Elec Wld & Engr —Aug. 23, 1902. No. 50219.

The Progress of Block Signaling on American Railways. Editorial review of a report of the Committee on Safety Appliances of the Am. Ry. Assn. 2000 w. Eng News—Aug. 21, 1902. No. 50066.

**Terminal Equipment.**

The Mechanical and Electrical Equipment of the Pittsburg & Lake Erie Railroad Tunnel, Pittsburg. An illustrated description of apparatus for warming and ventilating, lighting, power, etc. The equipment consists of boilers and stokers, coal and ash-handling plant, electric generating sets, air compressors, water distilling and refrigerating plant, pumping plants, etc. 2500 w. Eng Rec—Aug 2, 1902. Serial. 1st part. No. 49856.

**Tunnels.**

See Civil Engineering, Construction.

**Union Station.**

Construction, Design, etc., of the New Union Station for the Pennsylvania Railroad, Pittsburg, Pa. J. G. Giaver. Briefly reviews the progress in construction of business buildings, during the last 20 years, and gives an illustrated description of the design, construction work, etc., of this station which combines the features of a modern office building and a station. 4000 w. Pro Engrs Soc of W Penn—July, 1902. No. 50201 D.

The New Union Station P. R. R., Pittsburg, Pa. G. C. Clark. An illustrated article dealing with the location, preparation of site, approaches, elevated tracks and train sheds. 5000 w. Pro Engrs Soc of W Penn—July, 1902. No. 50200 D.

**Viaducts.**

See Civil Engineering, Bridges.

### TRAFFIC.

**Freight.**

A Novel and Important Freight Contract. A slightly abridged copy of a circular issued by A. B. Stickney, giving particulars of a contract just made with the beef shippers. 2500 w. R R Gaz—Aug. 15, 1902. No. 49991.

### MISCELLANY.

**International Congress.**

Subjects and Reporters—International Railway Congress. Gives the questions and reporters for the seventh session of this Congress, which will be held in Washington, D. C., May, 1905. 1500 w. R R Gaz —Aug. 22, 1902. No. 50069.

## STREET AND ELECTRIC RAILWAYS

**Accounting.**

See Industrial Economy.

**Berlin.**

The Metropolitan Railway of Berlin (Le Chemin de Fer Metropolitain Electrique de Berlin). A general description of the electric elevated railway in Berlin, with views of the important bridges and other structures. 8000 w. Rev Gen d Chemins de Fer—Aug., 1902. No. 50140 H.

**Berlin-Zossen.**

Results of the Tests on the Berlin-Zossen Experimental High-Speed Line. Extracts from a paper by Geheimer Baurath Lochner, printed in *Glasers Annalen,* giving new information not before published. 2800 w. St Ry Jour—Aug. 2, 1902. No. 49864 D.

**Brakes.**

Power Brakes for Street Cars. Report prepared by a committee for the Board of

Public Improvements in St. Louis. 1500 w. R R Gaz—Aug. 1, 1902. No. 49757.

**Car Driving.**

Lecture on Electric Car Driving. E. W. Elsley. A lecture to be given horsemen, enginemen and the novice on their first attendance for tuition in electric car driving. 1800 w. Elec Engr, Lond—Aug. 8, 1902. No. 50026 A.

**Cars.**

Convertible Cars. W. E. Partridge. Illustrates and describes the forms of railway cars which aim to combine the leading features of open and closed cars. 1800 w. St Ry Rev—Aug. 20, 1902. No. 50-228 C.

**Chicago.**

Loop Terminals and Transfer Station; Metropolitan Elevated R. R., Chicago. States the advantages of loop terminals, and gives plans and description of recent work in this city. 1300 w. Eng News—Aug. 14, 1902. No. 49990.

**Collisions.**

Runaway Trolley Cars. Editorial discussion of the recent accident at Gloversville, N. Y., and the operation of electric roads in general. 3000 w. R R Gaz—Aug. 1, 1902. No. 49763.

**Despatching.**

Interurban Car Despatching. Suggestions relating to a system for using the telephone, reviewing methods in present use. 2000 w. St Ry Jour—Aug. 2, 1902. No. 49869 D.

**Electric Locomotives.**

Electric Locomotives. Waldon Fawcett. Information concerning these engines of the storage battery type, stating their economic advantages. Ill. 1200 w. Loc Engng—Aug., 1902. No. 49878 C.

High Speed Locomotive (Schnellbahn-Lokomotive). W. Reichel. Describing the Siemens & Halske locomotive operating at 10,000 volts pressure on the Berlin-Zossen high speed military railway. 6000 w. Elektrotech Zeitschr—Aug. 7, 1902. No. 50167 B.

**Electrification.**

Electrification on the North Eastern Railway. Facts from the specifications concerning the change to electric power on one of the branches of this railway. Map. 2500 w. Engng—Aug. 15, 1902. No. 50094 A.

**Electro-Pneumatic.**

New Electro-Pneumatic System of Electric Railway Construction. Bion J. Arnold. A brief description of the writer's system with a statement of the results he believes will be accomplished by its adoption. 1500 w. Trans Am Inst of Elec Engrs—May, 1902. No. 50235 D.

**European Practice.**

Some Notes on European Practice in Electric Traction with Three-Phase Alternating Currents. Carl L. de Muralt. Brief description of typical roads using polyphase alternating currents, results of tests, etc. Ill. 7700 w. Trans Am Inst of Elec Engrs—April, 1902. No. 49811 D.

**Express Trains.**

The Express Train of the Future. Describes certain features of the new locomotives which are to be tested on the Berlin-Zossen line next year. 900 w. U S Cons Repts, No. 1415—Aug. 11, 1902. No. 49849 D.

**Feeders.**

The Distribution of Current in Railway Systems (Stromvertheilung auf Eisenbahnnetzen). Ph. Pforr. Developing a graphical method by which the distribution can be shown both for direct and branching circuits. 3000 w. Elektrotech Zeitschr—July 24, 1902. No. 50160 B.

**Finance.**

Electric Traction Finance. Editorial on the annual report of the working of the Glasgow tramways. 700 w. Engng—Aug. 8, 1902. No. 50037 A.

**Interurban.**

High-Speed Interurban Electric Railways. George H. Gibson. A highly illustrated discussion of the recent phenomenal development of interurban electric railways, with numerous examples of important roads. 5000 w. Engineering Magazine—September, 1902. No. 50184 B.

The System of the Youngstown-Sharon Railway and Light Company. Illustrated description of a recently opened line which is a good example of modern construction. 2000 w. St Ry Jour—Aug. 2, 1902. No. 49863 D.

**Ireland.**

The Sutton and Howth Tramway. Illustrated description of a line which gives a fine view of Dublin Bay. 1800 w. St Ry Jour—Aug. 2, 1902. No. 49870 D.

**Italy.**

The Ventimiglia-Bordighera Electric Tramway. Enrico Bignami. Brief illustrated description. 500 w. Elec Rev, N Y —Aug. 16, 1902. No. 49981.

**London.**

The Electrification of London. Concerning the bills before the British parliament, giving details of the schemes, and a summary of the route and points of interest of the different lines. Map. 2700 w. Nature—July 24, 1902. No. 49764 A.

**Marseilles, France.**

The Electric Tramways of Marseilles (Tramways Electriques de Marseille). Especially describing the central generating station and transforming apparatus. 3000 w. 1 plate. Génie Civil—Aug. 9, 1902. No. 50104 D.

The Electric Tramways of Marseilles (Tramways Electriques de Marseille). M. Denizet. A detailed description of the entire plant with map of the city and plans of the station and equipment. 8000 w. 4 plates. Ann des Ponts et Chaussées—1 Trimestre, 1902. No. 50127 E+F.

**Motor Testing.**

See Electrical Engineering, Measurements.

**Power Station.**

The Central Power Station of the Glasgow Municipal Electric Tramways. Illustrated detailed description of this station and its equipment. 3500 w. Power—Aug., 1902. No. 49731 C.

**Repair Shops.**

New Repair Shops of the Rhode Island Suburban Railway. Illustrated description of the arrangement and equipment of these shops for the repairing of the rolling stock of the street railway system. 1200 w. Eng Rec—Aug. 2, 1902. No. 49861.

**Short Railway.**

A Unique Railway. C. E. Price. Brief description, with illustrations of the "Angel's Flignt" in Los Angeles, Cal. It is 350 feet in length and rises 100 feet. It is built on the three-rail automatic turnout system. 500 w. Sci Am—Aug. 9, 1902. No. 49874.

**Signals.**

Block Signal Systems for Electric Railways. H. D. Emerson. Showing the adaptability of the block system, and its application by means of the "train staff," to high speed electric railways. 2000 w. St Ry Jour—Aug. 16, 1902. No. 50007 D.

**Stray Currents.**

Electrolysis in Water-Pipes. W. H. Humphreys. Read before the Brit. Assn. of W. Wks. Engrs. Presents facts relating to the injury of pipes from electrolytic action, giving extracts from the Board of Trade regulations. 6500 w. Elec Engr, Lond—Aug. 8, 1902. No. 50024 A.

History of the Electrolysis Question. W. H. Humphreys. Extracts from a paper and discussion at the annual meeting of the British Assn. of Water-Works Engrs. Presents facts relating o the action on gas and water pipes. 7500 w. Jour Gas Lgt—Aug. 5, 1902. No. 49978 A.

Injury to Metal Pipes by Electric Railways (Gefährdung von Metallrohrleitungen durch Elektrische Bahnen). R. Ulbricht. Giving the results of measurements of electric leakage in Dresden and in Leipsig, and the corrosion of water pipes in both cities. 2000 w. Elektrotech Zeitschr—Aug. 14, 1902. No. 50171 B.

See Gas Works Engineering.

**Suburban.**

The Aurora, Elgin & Chicago Railway. An illustrated detailed description of an important suburban electric railway, covering the most populous suburban districts of Chicago. Also describes the equipment, rolling stock, etc. 8000 w. St Ry Rev—Aug. 20, 1902. No. 50227 C.

**Surface Contact.**

The Cruvellier Surface Contact System. Illustrates and describes a new system that has been tested at Neuilly, near Paris, and which claims to have overcome some of the disadvantages of other contact systems. 2000 w. Engng—Aug. 15, 1902. No. 50092 A.

**Third Rail.**

The Electric Third Rail. W. B. Potter. Illustrates and describes a third-rail protection which is simple and effective. It consists of a channel of iron or plank supported by brackets directlv over and about 2½ inches above the third rail. 1400 w. St Ry Jour—Aug. 2, 1902. No. 49865 D.

**Through Traffic.**

Through Traffic on Tramways for Passengers and Goods. J. E. Waller. Read before the Liverpool Chamber of Commerce. Also editorial. Advocating through traffic wherever possible and showing the advantages of a large system of tramways. Discusses methods and conditions. 5200 w. Elec Engr, Lond—July 25, 1902. No. 49775 A.

**Trolley Omnibus Line.**

Trolley Omnibus Line Between Nice and Upper Monte Carlo. Presents the advantages of the auto-trolley system in many places, and gives an illustrated description of the system to be installed on this line. 3000 w. St Ry Jour—Aug. 2, 1902. No. 49871 D.

**Versailles.**

Electric Traction on the Line From the Invalides to Versailles (La Traction Electriques sur la Ligne des Invalides à Versailles). M. Mazen. A general description of the power house, transformers, and locomotives, with a plan of the line. 5000 w. Rev Gen d Chemins de Fer—Aug., 1902. No. 50138 H.

**Wear.**

Notes on the Wear and Maintenance of Tramways. C. F. Wike. Read before the Assn. of Munic. & Co. Engrs. Statistics and information concerning the wear of electric tramways, from observations made of the tramways of Sheffield, Eng. Ill. 1800 w. Elec Engr, Lond—July 25, 1902. No. 49773 A.

# EXPLANATORY NOTE—THE ENGINEERING INDEX.

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# THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

# CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

**Arches.**

Theory of Steel-Concrete Arches and of Vaulted Structures. By William Cain, M. Am. Soc. C. E. Size, 3¾ in. by 6 in.; pp. 181; plate, 1; figures, 24. Price, 50 cts. New York: D. Van Nostrand Company.

This is the second edition of one of the Van Nostrand science series, by the professor of mathematics in the University of North Carolina, about one-half of the present book being entirely new. This work contains a complete solution, graphical and analytical, of the elastic arch of variable section. The arch of steel and concrete combined has been taken up in detail to illustrate the general graphical treatment. Culverts and tunnel arches, groined and cloistered arches and domes of masonry are also discussed. The aim throughout has been to give a clear analysis of the principles involved, a knowledge of the fundamental principles of the equilibrium polygon being alone assumed.

**Armature Windings.**

Armature Windings of Direct Current Dynamos; Extension and Application of a General Winding Rule. By E. Arnold. Translated from the original German by Francis B. De Gress, M. E. Size, 6 in. by 9½ in.; pp. VI, 124; figures, 146. Price, $2.00. New York: D. Van Nostrand Company.

This is a translation, by the chief of the testing department of the Crocker-Wheeler Company, of the German treatise by the assistant professor of electrotechnics and machine design at the Riga Polytechnic School. Starting with fundamental principles, the author developes a general formula applicable to all direct-current armature windings. This rule not only embraces all known windings, but accomplishes even more: a general solution of the winding problem. By the aid of this rule and in conjunction with the various methods of connecting inductors which are shown, it is possible to design other windings. The work is very fully illustrated with winding diagrams, and contains a large number of designs, including many of historic interest.

**Civil Engineering.**

Civil Engineering as Applied in Construction. By Leveson Francis Vernon-Harcourt, M. A., M. Inst. C. E. Size, 6 in. by 9 in.; pp. XV, 624; illustrations, 368. Price, $5.00. London, New York and Bombay: Longmans, Green and Co.

This book treats of the principles involved in the different branches of civil engineering construction, and illustrates the methods by which these principles receive their practical application by describing a great variety of works. Different sections are devoted to materials, preliminary works, foundations and roads; railway, bridge and tunnel engineering; river and canal engineering, and irrigation works; dock works and maritime engineering; sanitary engineering. The volume is well illustrated, has a full index which gives a concise indication of the purport of each reference, and gives a comprehensive survey of the best practice and greatest works in the whole field of civil engineering.

**Drawing.**

Self-Help Mechanical Drawing; An Educational Treatise. By N. Hawkins, M. E. Size, 10 in. by 6½ in.; pp. 299; figures, 314. Price, $2.00. NEW YORK: Theo. Audel & Co.

The purpose of this book is to aid the aspiring student in making the first advance towards a thorough and useful knowledge of drawing in its several divisions, and to this end the subject has been treated in minute detail and profusely illustrated. Sections are devoted to chalk work, freehand drawing, geometrical drawing, materials and instruments, mechanical drawing, lettering, dimensioning, shading, section lining and colors, drawing-office rules, patent drawings, perspective and various other matters, and the book is concluded with a number of useful tables and a reference index.

**Electrical Calculations.**

Electrical and Magnetic Calculations for the Use of Electrical Engineers and Artisans, Teachers, Students and All Others Interested in the Theory and Application of Electricity and Magnetism. By A. A. Atkinson, M. S. Size, 5 in. by 7 in.; pp. VII, 310; figures, 45. Price, $1.50. New York: D. Van Nostrand Company.

This book is the outgrowth of several years of experience in teaching young men the rudiments of electricity, the author being a professor in Ohio University, and a large part of the matter was, in fact, prepared especially as an introduction to a course in electrical engineering. Different branches of the subject are taken up in the dozen chapters, and after the laws and formulæ have been developed, examples are worked out, illustrating the application of the principles, and giving familiarity with the processes. The book is well illustrated and has an index.

**Electrical Catechism.**

The Electrical Catechism. 533 Plain Answers to 533 Practical Questions about Electrical Apparatus, Compiled from the Regular Issues of *Power*. Size, 5½ in. by 9 in.; pp. 210; figures, 246. Price, $2.00. New York: Hill Publishing Company.

A very good practical book. The author has not attempted to cover the entire electrical field, but has treated the principles and practice of "heavy-current" electrical engineering in a clear and concise manner which will appeal particularly to the central-station or isolated-plant engineer, but will also be a helpful review for the engineering student. The book is fully illustrated and has an index.

**Electric Driving.**

Les Moteurs Electriques dans les Industries à Domicile. A report made to the Belgian Minister of Industry and Labor, by Ernest Dubois and Armand Julin. Size, 6½ in. by 10 in.; pp. 292. Paper covers.

This book contains the results of an examination of the mechanical, economic and social effects of the use of electric motors in domiciliary industries. The particular industries investigated were the Swiss watch-making industry, the silk weaving at Lyons and the ribbon industry at St. Etienne, France. The authors visited these localities and got their information at first hand. Each industry is treated in detail, with an abundance of facts and figures; and the conclusion arrived at is that while the electric motor renders labor much more efficient. it is doubtful whether it can prevent the ultimate centralization of industries in factories.

**Electric Railways.**

Les Chemins de Fer Electriques. By Léon Gerard. Size 6 in. by 9½ in.; pp. 288; illustrations, 42. Paper covers.

This is one of the monthly bulletins of the Belgian Electrical Society, and contains a comprehensive and well-illustrated review of electric railways in their various aspects. There is a comparison between steam and electric traction, and the application of electricity to main line railways is discussed. Tables are given, in which electric railways are classified according to different systems, and in which comparative weights and other data are shown; and there is a bibliography.

**Geometry.**

The Foundations of Geometry. By David Hilbert, Ph. D. Translated by E. J. Townsend, Ph. D. Size, 5½ in. by 8 in.; pp. VII, 132; figures, 52. Price, $1.00 (4s. 6d.) Chicago: The Open Court Publishing Company. London: Kegan Paul, Trench, Trübner & Co., Ltd.

The material contained in this book was given in substance by Professor Hilbert as a course of lectures on Euclidean geometry at the University of Göttingen, where he occupies the chair of mathematics. He sets up a system of axioms, and then discusses their relations to one another, and also the bearing of each upon the logical development of Euclidean geometry. The translation into English is very intelligent and finished, and the book is thoroughly well made.

**Graphics.**

A Graphic Method for Solving Certain Questions in Arithmetic or Algebra. By George L. Vose. Size 3¾ in. by 6 in.; pp. 62; figures, 29. Price 50 cts. New York: D. Van Nostrand Company.

This is the second edition of one of the Van Nostrand science series, by the professor of civil engineering in Bowdoin College. The graphic method described was suggested by the common mode of representing the movements of railway trains, in which time is represented by the abscissas, distances by the ordinates, and train movements by diagonals whose inclination shows the speed. Prof. Vose applies this method to a variety of algebraic problems, which it solves very simply and quickly.

**Labor and Capital.**

Labor and Capital. A Discussion of the Relations of Employer and Employed. Edited by John P. Peters, D. D. Size, 5½ in. by 8 in.; pp. XLIV, 463. New York and London: G. P. Putnam's Sons.

This volume is one of the "Questions of the Day" series and contains the principal articles contributed to a symposium in the daily newspapers controlled by Mr. W. R. Hearst, the *American and Journal*, the *Chicago American* and *The Examiner*, of San Francisco. The general question discussed was: "Are the interests of employer and employed mutual, and, if so, how can this mutuality of interest be made effective?" Further, one or more special questions. on trusts, labor unions, arbitration, model industries, socialism. etc., were addressed to each contributor College professors, national and state officials, ecclesiastics, lawyers. philanthropists and reformers, men of affairs and labor leaders took part in this symposium, and in most cases have revised their papers for the present volume, which altogether contains the broadest and most comprehensive discussion of the ever-present and all-important "labor-capital" question ever held.

**Minerals.**

A Classified List of Minerals, Precious and Other Stones. By Felix J. Troughton. Size, 4½ in. by 7½ in.; pp. 27. Price, 50 cents. New York: The Abbey Press.

This is an alphabetically arranged list of about 550 minerals and precious stones, with brief definitions.

**Municipal Year Book.**

The Municipal Year Book, 1902. Edited by M. N. Baker, Ph. B., C. E. Size, 6 in. by 9 in.; pp. LIV, 310. Price, $3.00. New York: The Engineering News Publishing Company.

This book, by the associate editor of "Engineering News," combines a directory of municipal officials and franchise companies, an exhibit of municipal and private ownership, and an outline of the leading public works and services in each of the 1,524 largest municipalities of the United States. It includes all the incorporated places of 3,000 population and upwards, by the U. S. Census of 1900, and, in addition, all New England "towns" of like size. The facts of most vital interest under each municipality are summarized and commented upon in the introduction, while the body of the book contains the detailed statistics of each place, such as population, assessed valuation, principal officials, ownership of public utilities, water supply, sewerage, street-cleaning, street sprinkling, garbage, fire department, electric wires. The towns are arranged alphabetically under their respective states and territories, which are grouped geographically. This work is a most useful one for everybody interested in municipal affairs, and forms as comprehensive a compilation of municipal statistics as probably ever has been made.

**Polyphase.**

Standard Polyphase Apparatus and Systems. By Maurice A. Oudin, M. S., Mem. Am. Inst. E. E. Size, 5¼ in. by 8 in.; pp. 289; figures, 169. Price, $3.00. New York: D. Van Nostrand Company. London: Sampson Low, Marston & Co.

This is the third edition of a work which was first published only three years ago, and which has now been brought up to date by describing the most recent applications of polyphase working. After a general introduction to alternating current theory, different classes of apparatus are described. Chapters are devoted to generators, induction motors, synchronous motors, rotary converters, static transformers, and station equipment and general apparatus, the last being particularly interesting, owing to the greatly increased demands upon modern controlling and switching devices. Then follow chapters on the two-phase, the three-phase and the monocyclic systems, the choice of frequency, the relative weights of copper for various systems, and the calculation of transmission lines, while an appendix contains the 1899 report of the Am. Inst. E. E. committee on standardization, to which, however, amendments have now been proposed. The book is well illustrated with many photo-reproductions of electrical apparatus, and has a number of diagrams and tables.

**Railway Engineering.**

Proceedings of the Third Annual Convention of the American Railway Engineering and Maintenance-of-Way Association, held at the Auditorium Hotel, Chicago, Illinois, March 18, 19 and 20, 1902. Size, 6 in. by 9 in.; pp. 501; figures, 9; plates, 11; paper covers.

The bulk of this volume is taken up with the proceedings of the association, consisting of papers, reports and discussions on various subjects relating to railway engineering, materials and accounts, and, in addition, the contents include past and present officers, list of members, deceased members, membership and mileage of roads represented in the association, standing committees and outline of committee work, committees of the board of direction, constitution and index.

**Refrigeration.**

Refrigeration, Cold Storage and Ice-Making. A Practical Treatise on the Art and Science of Refrigeration. By A. J. Wallis-Tayler, C. E., Assoc. M. Inst. C. E. Size, 5¾ in. by 8¾ in.; pp. XXI, 590; illustrations, 361. Price, $3.00. London: Crosby Lockwood and Son. New York: D. Van Nostrand Company.

This is a very comprehensive treatment of the subjects named in the title, well illustrated and made up into a handsome book. The various refrigerating processes and cold storage systems are fully described, there are chapters devoted to refrigerator cars and marine refrigeration, industrial and constructional applications, the management and testing of refrigerating machinery, the cost of working and the production of very low temperatures. An appendix contains useful tables and memoranda and a bibliography of refrigeration, while the work is completed by a full index.

**Sanitary Science.**

Principles of Sanitary Science and the Public Health, with Special Reference to the Causation and Prevention of Infectious Diseases. By William T. Sedgwick, Ph. D. Size, 6 in. by 9 in.; pp. XIX, 368. Plates, 6. Price, $3.00. New York: The

Macmillan Company. London: Macmillan & Co., Ltd.

The present volume is the outgrowth of a course of lectures given to the students of the Massachusetts Institute of Technology, where the author is professor of biology. It brings together and presents in a simple and logical form those fundamental scientific principles on which the great practical arts of modern sanitation securely rest. Different chapters are devoted to the human mechanism; diseases and their causes; the rise and influence of bacteriology; sanitary aspects of the struggle for existence; infection and contagion; various vehicles of infectious disease, such as sewage, water, ice, milk, uncooked foods; sewage disposal and purification; the establishment and conservation of purity in public water supplies; the prevention and inhibition of infection, decomposition and decay—asepsis and antisepsis; the destruction or removal of infection—disinfection and disinfectants. The principles laid down in this book are illustrated with an abundance of examples of actual occurrences, and the author has also drawn upon his own experience as biologist to the State Board of Health of Massachusetts, so that the work forms a very interesting and instructive presentation of a subject which is of the greatest and most general importance.

**Surveying.**

Plane Surveying. By Paul C. Nugent, A. M., C. E. Size, 6 in. by 9 in.; pp. XVI, 577; figures 320; plates, 6. Price, $3.50.

This is a text and reference book for the use of students in engineering and for engineers generally, by the associate professor of civil engineering in Syracuse University. It is a comprehensive treatise on surveying as practiced at the present time. It gives an account of linear measuring instruments and range poles; chain surveying; compass and general surveying: telescopes of surveying instruments; leveling; transit surveying; the planimeter and slide rule; topographical surveying; hydrographic surveying; mine surveying; the solar instrument; and United States public lands. Appendices treat of those modern developments in instrument construction and the theory and practice of surveying, the cyclotomic transit and phototopography. The book is copiously illustrated and enriched with many tables.

**Water Flow.**

Diagrams of Mean Velocity of Uniform Motion of Water in Open Channels; Based on the Formula of Ganguillet and Kutter. By Irving P. Church, C. E. Size, 12 in. by 9 in.; 11 diagrams. Paper covers. Price, $1.50. New York: John Wiley & Sons. London: Chapman and Hall, Limited.

It is perhaps quite generally admitted among hydraulic engineers that on account of the uncertainty usually attending the choice of a proper "coefficient of roughness" (*n*) in the use of Kutter's formula, it is well-nigh useless to observe great refinement in the employment of that well-known equation for the mean velocity of uniform motion of water in open channels. Suitable diagrams, therefore, can furnish solutions of this equation which answer every practical purpose. A collection of such diagrams, by the professor of applied mechanics and hydraulics in the College of Civil Engineering, Cornell University, is here presented, one for each of eleven different values of "*n*" (from .009 to .035), and ranging from 0.1 ft. to 25 ft. in the value of *R*, the hydraulic radius; the slope varying from 0.01 ft. per thousand to 100 ft. per thousand (that is, from $S = 0.00001$ to $S = 0.100$). Such being the range of application, covering all ordinary cases in practice, these diagrams constitute a fairly comprehensive "bird's-eye view" of Kutter's useful formula.

## BOOKS ANNOUNCED.

Elementary Coal Mining. By George L. Kerr. Philadelphia: J. B. Lippincott Co.

Metallography: An Introduction to the Study of the Structure of Metals, Chiefly by the Aid of the Microscope. By Arthur H. Hiorns. Pp. XIV, 158; ill. $1.40. New York: The Macmillan Company.

Metallurgy of Cast Iron: A Complete Exposition of the Processes Involved in its Treatment, Chemically and Physically, from the Blast Furnace Through the Foundry to the Testing Machine: A Practical Compilation of Original Research. 5th ed. By Thomas D. West. Pp. XX, 627; ill. and diagrams. $3. Cleveland: Cleveland Printing and Publishing Co.

How to Become a Competent Motorman; A Practical Treatise on the Proper Method of Operating a Street Railway Motor Car, also Giving Details on How to Overcome Certain Defects. By Virgil B. Livermore and James Williams. Pp. 232; ill. and diagrams. $1. Brooklyn: Wm. S. Livermore.

Cramp's Shipyard, 1830-1902. Published for private circulation by William Cramp & Son, Philadelphia.

Submarine Warfare, Past, Present and Future. By Henry C. Fyfe. New York: P. Dutton & Co.

Manual of Land Surveying. New edition. By F. Hodgman, M. S., C. E. Pp. 525; ill.; price, $2.50. Climax, Mich.: F. Hodgman.

La Convention du Mêtre et le Bureau International des Poids et Mesures. By Ch. Ed. Guillaume, Associate Director of the International Bureau of Weights and Measures. 4to.; ill.; price, 7 fr., 50c. ($2.25); Paris: Librarie Gauthier-Villars.

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# THE PRESENT INDUSTRIAL IMPORTANCE OF TECHNICAL EDUCATION.

*By Sir Philip Magnus.*

The importance of the problems of technical education and the present great activity of interest in the topic were recognised in our leading review last month. The following discussion by Sir Philip Magnus shows the trend of the thought and effort of the leaders of the movement in Britain, and may very profitably be read in connection with the review of three important papers by other great authorities on page 267 of this number. It is especially noteworthy that while Britain looks to Germany as the model, Germany is arraigning her own system as insufficient. It is doubtful, furthermore, if the United States can show anything which in scope, in purpose, and in magnitude compares with the great technical schools at Manchester, Birmingham, or Sheffield.

Sir Philip has been for more than twenty years in the forefront of progress in British technical education, as director of the City and Guilds of London Institute, member of the Royal Commission on Technical Education, of the Senate of the London University, and of the Technical Education Board of the London County Council.—THE EDITORS.

DURING the last few years so much has been written on the subject of technical education, and so much has been done by Parliament, by county councils and by the livery companies of London, to bring its advantages within reach of all classes of the community, that it would seem there is no further need to insist upon its importance, and that nothing new can be said on so trite a subject. This may be so. Nevertheless it is a fact that some of our industries have suffered, and are still suffering, through lack of interest in this important question, and owing to the insufficient efforts that have been so far made to place Britain educationally on a level with Germany and the United States.

The delay in meeting requirements which have been so frequently pointed out, is perhaps partly the result of the exaggerated statements so frequently introduced into the discussion of this subject. Practical men have refused to believe that our industrial shortcomings are due entirely to the lack of educational facilities. They recognise that in this question of trade competition other considerations than those of education are factors of material significance. Among the social and economic causes of a country's industrial prosperity or failure must be included such considerations as commercial tariffs, hours of labour, trades-union regulations, means of transport, the laws regulating patents, as well as the essential character of the people—a matter which cannot be hastily altered by the foundation of any number of technical institutes. That technical education is the panacea for all the evils of which manufacturers and merchants and agriculturists from time to time complain, cannot for one moment be admitted. At a time, too, when the Board of Trade statistics shew that the commercial condition of the country is fairly prosperous; when enormous sums of money can be taken out of capital for unproductive expenditure, without interfering with or dislocating trade; when British manufacturers are unable to meet the heavy orders which they are receiving,—the statement that their competitors in Germany, Switzerland, and the United States are gaining ground on them, and that Britain is gradually losing one branch of industry after another, for lack of adequate education, would seem at least to need some qualification.

Then, too, it cannot be said there is that agreement which is desirable among the educational physicians, who so readily prescribe for us. Not long ago we were told that our artisans were lamentably deficient in technical knowledge and skill, and the public was asked to make large contributions towards the establishment and maintenance of polytechnic institutions, with the view of stemming the flow of foreign imports into this country. Others warned us that the reason of our inability to hold our own in trade and commerce was the absence of all organisation in our secondary schools—that the teaching was defective and the scholars in attendance were too few—while other equally eloquent advisors insisted that our recovery lay in the provision of further facilities for the higher technical instruction, in the establishment of new universities, in the endowment of research, and above all in the abolition of examinations.

With the view of demonstrating our inferiority to Continental countries, in one or more of these respects, enquiries have been instituted into foreign educational systems, blue books and special reports have been published by the Government, and private commissions have been sent from several of our large manufacturing centres, with the result that probably no people are better informed as to their neighbours' educational facilities and methods than we are. Even now, further enquiries are being made; and it is understood that an important body of experts will start in the late autumn to make new investigations into the organisation of trade and education in the United States and in other countries. It is very doubtful, however, whether we can expect to gain much by fresh enquiries, and it might be well if the people of Great Britain would recognise that the time has now come for applying the information we have already acquired to the remedying of such defects in our educational system as may have been proved to exist. Whilst such a survey of our deficiencies is very desirable, it would be lamentable if we were to attempt to remodel our methods altogether on foreign lines. A nation's educational organisation is a part of its history and character, and must be adapted to its special industrial requirements. The information we have obtained as to the relations which other countries have established between trade and training is eminently useful in shewing us:—(a) The particular industries, if any, which we have wholly or partially lost through our educational shortcomings, and the extent to which other countries have benefitted by any superiority in their methods or organisation; (b) The extent to which trade and commerce may be helped by technical or other schools; and (c) The relative degree of appreciation among different countries of the value of education in the promotion of industry. Such information will be found in some of the documents to which I have referred, and more fully in the Consular Reports, which do not appear to be as carefully studied as they should be by those whose interests are most affected by the valuable facts and statistics they frequently contain.

Of such reports one of the most informing was that issued in July, 1901, on "Chemical Instruction and Chemical Industries in Germany" by Dr. Frederick Rose, His Majesty's consul at Stuttgart. Dr. Rose has had the advantage of studying chemistry in German laboratories, and his residence at Stuttgart, the seat of one of the best technical high schools, had given him the opportunity of carefully investigating the extent to which German trade had profitted from the higher technical training which such schools provide. Dr. Rose tells us that the principal object of his report was "to shew the direct influence of chemical instruction upon the growth of chemical industries," and the facts and figures he adduces prove unmistakably that the great development of the chemical industry in Germany is due very largely to the foresight of the different States in providing facilities for the thorough training of chemists. There can be no doubt that Germany's success has been very largely due to the fact that manufacturers and managers in every department of industry have been themselves sufficiently well educated to recognise the advantage of scientific, as distinguished from rule-of-thumb, methods; and this appreciation of the value of science on the part of those who have been and are in a position to avail themselves of its methods and results, has been one of the most potent factors in the development, during the last fifty years, of trade and commerce in Germany. Mr. George Beilby, a chemical manufacturer of Glasgow, states in the appendix (to a report to which fuller reference will be made later on):

> "I attribute the leading position of Germany in certain chemical industries more to the appreciation by her commercial leaders of scientific methods than to the mere possession of a multitude of higher trained graduates in science." * Let us now consider some of the facts Dr. Rose has been able to collect. He tells us: "The growth of the German chemical industries has advanced hand in hand with the progress and discoveries made in chemical science and the increased facilities for chemical instruction. The annals of industrial progress shew few examples of such intimate relationship between pure and applied science. The chemical industries in Germany, in common with other industries, were slower in their development during the first half of the nineteenth century compared with France, the United Kingdom, and the United States, but recovered lost ground with great rapidity during the latter part of the century."

It is very difficult to over-estimate the benefits conferred upon agriculture by the discoveries of Liebig. It was he who in 1840 shewed that if soils are not to become impoverished, those salts of which they are deprived by agriculture must be restored to them, and this discovery led to the working of the salt mines of Stassfurt, and of the Anhalt salt strata. "The total value of the production from Prussia and Anhalt between 1860 and 1890 amounted to £11,500,000." Prior to 1860, Russia had exported to Germany large supplies of potash, but since then Germany has imported less and less, and in 1887 Russia began to import German potash. Experiments, begun in German laboratories in 1855, shewed that potassium saltpetre previously imported from the East Indies could be more cheaply manufactured, and as a result of these experiments, the importation of potassium saltpetre into Germany has entirely ceased, and in the year 1899, 13,-

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* Report of the special committee of the Technical Education Board of the L. C. C. on "The Application of Science to Industry." p. 27.

361 tons were exported to other countries. The increase in the production of beet sugar from 8,822 tons during the years 1836-40, to 1,664,677 tons in 1899, is a further remarkable example of the progress of German trade due to commercial enterprise.

The report from which these facts are quoted contains many other instances of the developement of chemical industries in Germany. The most remarkable of these, and the one most frequently adduced, is the rapid growth of the manufacture of artificial colouring matters. Some of the principal discoveries which led to this important industry were made in England, and it is from England that the raw material is largely exported. Moreover, from 1858 to 1872, the bulk of the business was carried on in London, whereas since then, owing almost entirely to the succession of discoveries in German laboratories, and to the rapid application of those discoveries by well trained intelligent manufacturers, the industry has practically left us. "Of the world's annual production of alizarine in 1890, amounting to about 25,000 tons. Germany contributed about 22,000 tons." In 1874 the value of the dye industry to Germany was £1,200,000, and in 1898 it had increased to £6,000,000, and the excess of exports over imports amounted in value to £4,891,100. Not content with this increase of trade, the principal dye works in Germany are preparing to erect branch establishments in America, France, and Russia.

In 1882 I was shewn by Professor Beyer in his university laboratory in Munich a comparatively simple means for the artificial production of indigo. At that time, the discovery was not ripe for manufacturing purposes. The indigo was produced in small quantities in a test tube. Since then, the import into Germany of natural indigo, which in 1886 amounted to 1,036 tons, has altogether ceased, and in the year 1899 Germany exported 256 tons of the same material artificially prepared. It is claimed, too, that the new indigo is in many respects superior to the natural product, in which the percentage of colouring material, instead of being fixed, is a variable quantity. As affecting our own trade it may be mentioned that the value of the export of indigo from India has decreased from 51,92,672 Rs in 1899 to 27,85,627 Rs in 1900.

I might quote largely from other documents to show that Great Britain, notwithstanding her present large volume of trade and her continued commercial success, has been losing ground as compared with the United States and other countries in certain branches of industry. The commercial prosperity of a country cannot be correctly estimated by the actual value of its exports and imports; it is the comparative rate of developement which marks its progress. For if it can be shewn that other nations are gradually gaining on us, and that we are living, so to speak, on our capital, both as regards stored-up resources and *prestige,* the time may come when we may find ourselves dangerously distanced by other countries in the competition for trade, and it may then be too late to organise those means of self-defence and attack which have been successfully employed by our foreign competitors.

In the report of the special committee of the London County Council, to which I have already referred, it is, I think, conclusively shewn that of late years we have lost other branches of trade than those above named, and that this loss is largely due to the superior educational equipment of our neighbours. An industry which we are rapidly losing is the production of fine glass for scientific and optical purposes.

> "A generation ago, the bulk of this manufacture was in English hands. After long continued experiments in the laboratory, German chemists have succeeded in introducing such modifications in the manufacture of optical glass that the optician has been enabled to place on the market lenses approaching more nearly to mathematical perfection than any previously manufactured in this country. It is also worthy of notice that the experiments carried out in connection with optical glass have created in Germany several subsidiary industries."

This developement of subsidiary industries is a fact of considerable importance. There are bye-products of experiment, as of manufacture, and these bye-products are often found to be commercially more valuable than the results for which the original experiments were undertaken. The report goes on to say that among those subsidiary industries, now almost wholly in the hands of the Germans, are the manufacture of thermometers for accurate physical measurements; the manufacture of X-ray tubes, the manufacture of lamp chimneys which do not burst, and boiling flasks which do not crack. The help these industries have obtained from scientific experiments carried on by subsidies granted by the Prussian Bureau of Education, is fully acknowledged in the introduction to the price list of the Jena Glass Works.

Recently, in London, classes for the study of trade optics have been established, under the auspices of the Spectacle-Makers' Company, at the Northampton Institute, Clerkenwell These classes, although serving a very useful purpose, fail to give that complete scientific training which the practical optician requires. What is wanted is a well-equipped department in connection with one of our university technical schools, in which research work in the manufacture of the material itself, and in the scientific principles underlying the production of optical instruments, may be conducted by specially appointed professors assisted by their students.

In certain branches of the pottery trade we are also losing ground, through the superior education of our Continental rivals. No one can have visited a pottery in Staffordshire without comparing it to its disadvantage with some of the most up-to-date firms in France and Germany. The absence of any attempt at applying scientific method and scientific processes is characteristic of most of our English potteries; and one is struck with the fact that, here in England, the managers or heads of firms have seldom had any special training, whilst on the Continent those who have to direct the works have generally received a sound scientific education, supplemented by special technological instruction. Professor Thorpe tells us that in America the manufacturers are nearly all chemists; and, although they have not such good raw materials as we possess, "they are rapidly overtaking us in developing the manufacture of ceramics."*

It must be understood that it is very difficult to identify the individual industries which owe their special development to educational opportunities, and whilst in the report issued by the London County Council some three or four different trades are cited, in which such a causal connection has been established, these must be taken as typical only of other industries which have been created or improved through the far-sighted policy of the State, in liberally encouraging scientific research, and in affording every possible opportunity for the application of scientific methods to industrial process. Only recently there appeared in the *Times* a paragraph stating:

> "As evidence of Continental enterprise in engineering work, it may be noted that an order for thirty-two locomotives has recently been placed by the East Indian Railway Company with a German firm, who tendered a price nearly 20 per cent. lower, and for delivery nearly 25 per cent. sooner, than the English firm whose tender stood next."

At the railway works in Cairo, where contracts are made by tender, large quantities of machinery are supplied by German firms; and within a few weeks only of the proclamation of peace in South Africa, German agents were on the spot obtaining orders for machinery and tools, for which, without reference to the firms they represented, they were able to quote definite prices. Professor Ayrton, the well-known electrical engineer, states:

> "If you want a piece of electrical machinery constructed according to a well drawn out specification, do not send to an English firm. For dynamos,

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* Report T. E. B., p. 4.

> manufacturers send to Germany; for magnet steel, to Germany or France; for the material for resistance coils, to Germany, and for the paper used for insulating underground cables, to America." *

The great lesson which Germany and Switzerland have taught us has led to a developement of educational zeal in other parts of Europe; and although we in this country have been slower to profit by it than other countries, we are gradually awakening to the necessity of providing a more efficient training for all classes of the working population, and of giving to the select few, who are capable of usefully applying it, every opportunity of obtaining the highest university training. In the United States this enthusiasm for education has sunk deep into the spirit of the people, and as a consequence millionaires vie with one another in their efforts to establish and endow educational institutions, in which the youth of the country may obtain the most complete training for every conceivable career, and ample opportunities may be afforded for the prosecution of research.

Every engineer knows the extent of our dependence on America for some of our most useful machinery. Our shops as well as our technical schools are largely fitted with American tools, and we are in danger of suffering in this country not only from the superior inventiveness of our American cousins and their characteristic originality in grappling with commercial problems, but also from their ever improving facilities for all scientific experiments.

It is a fact which we cannot too soon recognise, that the main purpose of the enormous expenditure of first-class States on their naval and military services is the protection of their commerce and the increase of their trade; and except for home defence, this expenditure must be wholly unprofitable, unless the people are so trained as to be able to utilise to the best advantage the results which by force of arms have been secured. We, in this country, have spent during the last twenty-five years many millions sterling on war-ships which have never been in action, and most of which are now obsolete and of little use. The nation has not grudged that expenditure, knowing full well that our navy is our first line of defence, and that unless our shores and possessions are properly defended, war-like operations elsewhere cannot be successfully carried on. But it would seem that we have yet to learn that the ability to utilise for commercial ends the results of military successes depends very largely on the efficiency of our educational system, and on the special training of the people for industrial purposes. What that training should be is not yet definitely settled.

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* Report T. E. B., p. 3.

It is a question of some difficulty, one that involves the consideration not only of school organisation, but also of the most suitable subjects and the best methods of instruction.

In a letter to the *Times,* August 5, on "The Military Education Report" Professor Armstrong truly says: "We now know that the most effective way of teaching young fellows to think for themselves is to give them real practical training in scientific method;" and if we are to have well-trained men, capable of initiating action, and of anticipating results, the aim of education must be to teach them "to think for themselves." To shew why it is that "training in scientific method" is the best discipline to this end, Professor Armstrong quotes Huxley:

> "The great peculiarity of scientific training, that in virtue of which it cannot be replaced by any other discipline whatsoever, is this bringing of the mind directly into contact with fact, and practising the intellect in the completest form of induction; that is to say, in drawing conclusions from particular facts made known by immediate observation of nature."

What strikes one most on comparing German with English education is its technical character. Education in Germany has been, up to the present time, a subject of more serious study than in England. It is an essential part of the nation's life, and is so organised as to bear directly upon the career and occupation of each individual. In this sense it is distinctly technical. Students in Germany do not flock to the universities to acquire a smattering of culture, nor to obtain that elementary knowledge of the classics which serves as a class distinction, nor even to rub off by contact with other students their essential angularities. They go there to study what will be useful to them in their future career, and they enter the faculty or department which affords the special training most helpful to their life's work. This is especially to be noted in the case of the sons of manufacturers, or engineers, or business men, who may be expected to follow in their fathers' steps. In this country the rich manufacturer's son goes to Oxford or Cambridge with no definite object, and enters upon a course of study that has no reference whatever to his future calling. This is not so in Germany. There, he acquires at the university or technical high school the special knowledge which has a distinct relation to his business; and, as a result, he learns to realise the importance of expert help, and is constantly watching for the opportunity of applying to the improvement of his trade any discovery or new invention which his technical knowledge suggests is worthy of the trial. The journals of scientific societies are carefully studied, and he maintains, either personally or through his staff of experts, a close and uninterrupted acquaintance with the published results of laboratory investigations.

Writers, and more frequently speakers, fall into a common error of supposing that equal facilities for the higher training, literary or scientific, do not exist in this country. The question is not so much one of facilities, as of appreciation of the importance of the higher education, of its training and discipline, and of the value of scientific method and investigation in every branch of industry.

It is true that we do not yet possess in this country any institution as well organised, both as regards its staff of professors and the equipment of its laboratories, as some of the technical high schools in Germany. In London there is none that can compare in these respects with the well-known school at Charlottenburg, Berlin. The higher technical education of London is wanting in co-ordination. Instead of having one central college, in which advanced teaching in all branches of engineering and chemical technology is concentrated, we find different institutions competing with one another for students, each imperfectly equipped, and all engaged in very much the same kind of work. As a result, whilst there is unnecessary over-lapping of facilities for training in certain sections of knowledge, there are other branches for which no opportunities of technical training are provided. It is hoped that in due time, as the University of London acquires a larger measure of control over the teaching institutions, this waste of effort will be avoided and the teaching resources of London will be economically combined. It may be as well to remind our readers that at Charlottenburg there are ninety-one professors, distributed over six departments, in addition to demonstrators and teachers, and that the number of students in the winter semester, 1901-2, was four thousand four hundred and forty-one.

The organisation of a central school of technology for the training of students in different branches of industry might be effected without any great outlay, by the addition to one or other of our existing institutions of those departments for which adequate provision has not yet been made, and by bringing together, with freedom to each to pursue his special work, the several distinguished professors who are now occupied in giving, in separate schools, almost identical courses of instruction. What is wanted in the higher education is the application to it of the economic principles of co-operation and division of labour. The mere existence of a great central school, properly equipped and organised, would indicate the importance of the higher technical education, and would help manufacturers and others to realise the value of science in relation to industry. There is no doubt that the size and prominence of the buildings which have been erected in many German towns for the purposes of technical instruction, have had the effect of rivetting the attention of the people on the close connection between industry and science, and have thus helped to create a general appreciation of its value. Certain it is, that a far larger proportion of the industrial population of Germany graduate in the higher technical schools, and there is consequently a greater and more available supply of scientific experts for the different sections of manufacturing industry. Moreover, the period of training at a German university is generally much longer than in England, and the number of trained students qualified to take part in the higher branches of scientific investigation and research is undoubtedly greater, in Germany and in the United States, than in this country.

As regards the education of engineers, there is a growing opinion that the instruction given in our universities and technical colleges needs to be supplemented by concurrent practice in actual engineering work. There is a complaint that the teaching is too academic. The successful engineer must be of necessity a man of business. He must understand the commercial conditions under which work is carried out, and he should have acquired, at a comparatively early stage of his career, some familiarity with the different classes of work people, and a knowledge of how they are governed and controlled. For these reasons, several eminent engineers are of opinion that the present system of sending a youth to spend three years in the engineering faculty of a university, before commencing actual work, is not the best preparation for any branch of the profession.. Moreover, it is thought that the university terms, occupying on the whole not more than seven months of the year, are too short for the proper training of engineering students, and involve unnecessary breaks in their work. It has been suggested, therefore, that students in engineering should divide the session into two parts, and should spend six successive months in each year at the university or technical college, and the remainder of the year in engineering practice. This arrangement would certainly prove advantageous to the students, and might be equally so to the professors, who would thus obtain a continuous period of leisure for their own investigations or private practice. In Germany, many engineering firms receive students from the polytechnics during the long vacation, and the German student values very highly the practical experience which he is thus able to acquire during the period of his university course. But the system now suggested would be an improvement on that adopted in Germany. It would combine theoretical and practical teaching during the entire period of the student's apprenticeship and, whilst enabling the professors to omit from their present courses some part of the collegiate workshop training, would leave more time for continuous instruction in the purely scientific subjects on which the practice of engineering is based.

This proposal, of which more will be heard later on, shows how necessary it is to approach the problems of technical education altogether free from the bias and the traditions of the old classical and literary training. The practice of the older universities, whether here or abroad, is no guide to what is best for the student who is to follow the calling of a manufacturer or engineer. The educational problem must be considered in relation to professional and commercial requirements. And it is essential that the commercial aspect of the question should not be lost sight of. What the country needs are business men with a knowledge of science and a just appreciation of its value as applied to industry—men who have been trained in the methods of investigation and research. Mr. A. G. Green, a well-known consulting chemist, says: "The most that can be hoped is to educate the rising generation of commercial men to a better appreciation of the value of science for the development of our industries."* To induce manufacturers to recognise the value of science in its application to industry, and to hold out inducements to science students to familiarise themselves with the ways of commerce, are the great desiderata for the improvement of our industries. The advice of Mr. George Beilby to the Committee of the London Education Board is worth repeating: "Increase the knowledge and respect for science of our business men, and develope in our students of applied science a corresponding respect for the business and economical aspects of industry." To give this twofold training should be the endeavour of the commercial and industrial faculties of our new universities and the aim of our higher technical education. I conclude this contribution to the study of the question of the industrial importance of technical education by a quotation from the report of the Royal Commissioners on Technical Instruction, which is as applicable now, as it was in 1884, when the report was published:

> "The Germans and Swiss have been and still are distinctly before us, not only in the facilities which they possess of obtaining the highest technical training in their numerous universities and polytechnic schools, but by what is even more to the point, in the general recognition of the value and importance of such training for the successful prosecution of any branch of applied science."†

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* Report T. E. B., p. 39.

† Report, Vol. I., p. 225.

# COST OF ENERGY IN ELECTRICAL SUPPLY.

*By Alton D. Adams.*

Exact data of costs are always useful and interesting to those who are studying the economy of production engineering. Mr. Parsons' study of the costs of electric energy from isolated plants, published in THE ENGINEERING MAGAZINE for January and February, 1902, has proved a work of permanent value worthy of reissue in book form; Mr. Adams to a certain extent supplies the complement to this work in the form of figures for large central stations.—THE EDITORS.

FIGURES for the cost of electrical energy are scarce. It is easy to estimate the probable cost of energy at an electric plant operating during a fixed number of hours per day at full load, when desired conditions as to equipment, fuel, and water are assumed. But this is not the problem in systems of electrical supply. Managers of such systems are glad to learn the costs per unit of energy output elsewhere, but hesitate to name their own, for business reasons. A single State in the Union, Massachusetts, collects data as to the costs of electrical energy at the supply systems within its limits, through a commission; but these data are reserved to guide the commission in its regulation of the lighting companies, and are not published. In one instance, on Feb. 20, 1901, this commission made a specific statement covering the cost of electrical energy. This statement was in reply to an order from the House of Representatives, which directed a report on "the cost of manufacturing and distributing electric light." The answer to this order was a general statement, applying to no particular system, that the cost of manufacture varied from less than two to more than seven cents per kilowatt hour, and the cost of distribution from one to nearly six cents for the same unit. These figures are notable in the wide range of costs indicated, and may well lead to a consideration of the reasons for such variations.

Important among these reasons is the fact that existing systems of electrical supply represent a growth. It is easy to demonstrate that expenses of operation would be lowered, and efficiency raised, if the older generating and distributing equipments were replaced at once by others of the latest design. But such a move is impracticable for two reasons. In many cases funds are not forthcoming for such improvements, however desirable they may be. In other instances, while expenses might be lowered and efficiency raised by the adoption of the latest apparatus, the resulting increase of fixed charges would more than offset the possible saving in operation. Again, fuel, boiler and condensing water, and water power, vary greatly as to cost per unit in different locations, so that absolutely uniform equipments could not lead to equal results.

Through the range of capacities represented by the great majority of electric-lighting stations there is a strong tendency toward smaller costs of operation per unit of output as the plants grow larger. yet these plants must in general be limited in capacity by the demands of their service areas. The kinds of load carried, whether street or commercial lighting or service to stationary motors, as to their relative amounts, are far from uniform in different places, and this introduces another variable element in costs per kilowatt hour. Densities of electrical loads over their distribution areas are subject to wide variations, with consequent differences in expense per delivered unit.

The foregoing are some of the main factors that tend to varying costs per kilowatt hour in electric systems. Compared with a plant which is operating a fixed number of hours daily at full load, systems of electrical supply necessarily present a much higher cost per kilowatt hour. At a central electric station, the maximum load comes on and goes off rapidly and continues during hardly more than one hour daily. Compared with this maximum load, the minimum load is usually less than twenty and the average load less than fifty per cent. To meet these conditions with a steam plant, there must be fires under some of the boilers during several times the daily period that they are actually furnishing steam. Furthermore, the changing loads make it practically impossible to keep all of the operating engines at full load. If water power is employed to carry the entire load, some of the wheels must work at less than full capacity, and the space for water storage during a part of each twenty-four hours must be large, if the daily flow of water is not much greater than that necessary for the total output of energy. With either steam or water as the motive power the capacity of generating apparatus at the central station must be about double the average load.

In systems of electrical supply a large part of the cost of energy is added after it leaves the station. Not infrequently the cost of energy at dynamo terminals is increased fifty to seventy-five per cent. by the time it reaches the premises of consumers. The investment in distributing lines and apparatus outside of central stations is often as great as the investment in all the generating equipment inside, both steam and electric. Besides the interest, depreciation, and repair charges on this outside apparatus there are important labor charges incident to its regular operation.

In view of the foregoing facts it is clear that experience is the only reliable guide to the cost of energy in electrical supply. Costs per kilowatt hour here given are derived from annual expenses of operation by dividing the totals by the numbers representing the yearly outputs in kilowatt hours. Systems to which the results relate vary several hundred per cent. in their annual outputs of energy; a part use steam as their only motive power, and the others drive electric generators with water power alone or with water and steam combined. In every case, except one, it has been possible to separate operating expenses into those at the generating station, those of distribution, and those covering management, taxes, and incidental expenses. Station expenses include only the labor and materials actually consumed there in operation and repairs. Expenses of distribution cover the labor and materials employed in the operation and repairs of the lines and other apparatus that completes the connection between the generating station and the local circuits of consumers, also the cost of collection. Management and incidental expenses include all sums paid to officers of the electric companies, the hire of clerks, and general office expenses.

All of the costs here given, except the first case, relate only to the management, operation, and repairs of electric systems and include nothing for depreciation, interest, or dividends. These last named charges are omitted entirely, because they vary greatly in different systems, and are largely regulated by financial policies and personal opinions.

During a recent calendar year, a certain electric station driven entirely by water power delivered more than five-million kilowatt-hours of energy for use in a system of electrical supply. This energy was sold to the supply system at a rate which must be presumed to have covered interest or dividends and depreciation as well as operating expenses. The total cost of this energy to the electrical-supply system, delivered at its sub-station, was almost exactly 0.4 cent per kilowatt hour. This rate includes nothing for distribution, management, or incidental expenses on the part of the supply system. The figure just given seems to represent the total cost of electrical energy from a rather small water power when transmitted less than a score of miles, and a moderate return on the investment besides.

The next case is that of an electrical-supply system which delivered somewhat more than three-million kilowatt hours to consumers during a recent year. More than 70 per cent. of this energy was derived from water power by a transmission of less than ten miles, and the remainder was developed by steam power. For this supply system the total cost of energy was 3.85 cents per kilowatt hour, covering every expense of operation. At the generating stations alone the cost of delivered energy was 1.75 cents per kilowatt hour. Distribution added 1.26 cent to the cost of development, and the sum of expenses for taxes, management, and incidentals was 0.82 cent, raising the total cost per kilowatt hour to the figures named. The system to which these data apply has in the main a first-class equipment, is managed with ability, and supplies light and power in a prosperous city. It should be noted that the system just considered comes within the lowest figures named by the Massachusetts commissioners for the cost of energy at electric stations, that is, less than two cents per kilowatt hour, and is nearly down to the one cent per unit named by the same authority as the lowest cost of distribution. For the amount of energy yearly delivered the cost per unit in this system is exceptionally low, due in part no doubt to the large percentage developed by water power.

Unlike the foregoing, the following supply system develops all of its energy with steam power. Data covering costs per kilowatt-hour in this system are presented for three recent successive years. During the first two of these years the output of the system was about one and one-half million, and during the last of the years a little under two and one-half million kilowatt-hours.

| | At Station. | For Distribution. | Management, Taxes and Incidentals. |
|---|---|---|---|
| First year | 2.30 | 1.95 | 1.27 |
| Second year | 2.18 | 1.57 | 1.49 |
| Third year | 2.21 | 1.58 | 1.06 |

COST PER KILOWATT HOUR, IN CENTS.

In the first year for which the data of costs are given, this electrical system represented many features which it is desirable to abandon. All engines at the generating station were then of the simple type, and operated non-condensing. A constant supply of fresh feed water from city mains was required for the boilers, and no economizer was in use. Electric generators of four different types and voltages were belted to engines or shafting, and delivered energy to four sets of distribution lines. In that year a change to economizers, condensing engines, and direct-connected electric generators of a single type and voltage began, and has only recently been completed. In the main the figures for the costs of energy show the lowering tendency of these changes, though results have been retarded by extra labor of operation during the gradual reconstruction. It is probable that the year next after the third given will show further material reductions in the costs at the station and for distribution. Viewing the three years, the cost per unit of energy at the station has come down 4 per cent., for distribution 20 per cent., and for management and incidentals 16 per cent. The total reduction has been from 5.52 cents to 4.85 cents per kilowatt hour.

Compared with the system before mentioned, which derived more than 70 per cent. of its energy from water power, this steam system, in the third year, delivered about one-third less energy. Nevertheless the cost of energy at the station of the steam system was only 0.46 cent more per kilowatt hour than the like cost at the stations of the larger system. Distribution necessarily costs more per unit at the smaller system independently of the amount of delivered energy, because its area of distribution is much larger.

Station capacity and the annual volume of delivered energy are not always great where the cost per kilowatt hour is low. An example of this sort is found in a small system of electrical supply that delivered a little less than one half-million kilowatt hours during the year ending June 30, 1901. It should be noted that the annual output of energy by this small system is less than one-seventh of that by the larger and about one-fifth of that of the smaller of the two systems last considered. This small system depends entirely on steam for a motive power, and its single station operates with belted engines and dynamos that deliver current at three voltages to as many separate sets of distribution lines. No economizers are used here, but the engines run condensing. Cumberland coal at this plant costs $3.50 per long ton delivered in the bins. Condensing water was obtained from a private source. In spite of its disadvantages of small capacity and antiquated equipment, the cost of energy to this small system during the year named was only 4.47 cents per kilowatt hour for manufacture, distribution, management, and incidentals. This cost is only 0.62 cent larger than that for the system that delivered more than three-million kilowatt-hours, and is 0.39 cent smaller than that in the system that delivered more than two-million kilowatt hours per year. As might be expected, the small system makes its poorest showing at the generating station, where the cost was 3.12 cents per kilowatt hour. This cost is nearly twice as great as that in the system where both water and steam power were used, and is nearly 50 per cent. greater than the station cost for the large system using steam power only. An equipment of direct-connected units of uniform type and voltage, together with an economizer, would materially reduce this rate of 3.12 cents per kilowatt hour. About 8 per cent. of this rate is made up of a sum paid for current purchased from another system, because the station capacity was not sufficient at certain times. In the matter of distribution this small system is favored, its load being confined to a relatively small area, and the cost of distribution was only 0.46 cent per kilowatt hour, or less than one-half and one-third respectively of the like costs in the other two systems. Management and incidental expenses for the small system were only 0.87 cent per kilowatt hour, or between the two like costs previously named.

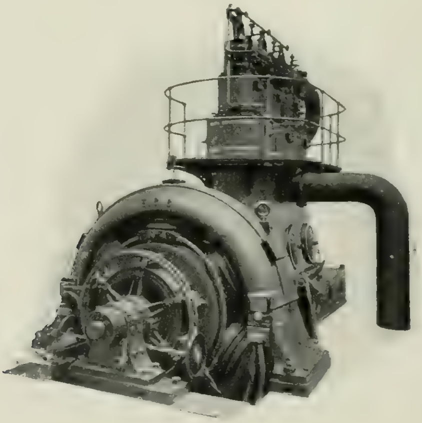
| Yearly output of energy in kw. hours. | At Station. | For Distribution. | Management and Incidentals. | Total. |
|---|---|---|---|---|
| Between 3 and 4 million ....... | 1.75 | 1.26 | 0.82 | 3.85 |
| *" 1.5 and 2 " ....... | 2.30 | 1.95 | 1.27 | 5.53 |
| *" 1.5 and 2 " ....... | 2.18 | 1.57 | 1.49 | 5.26 |
| *" 2 and 2.5 " ....... | 2.21 | 1.58 | 1.06 | 4.86 |
| " 0.4 and 0.5 " ....... | 3.12 | 0.46 | 0.87 | 4.47 |
| " 5 and 6 " ....... | 0.40 | Purchased from water-power station. | | |

* Same system in three successive years.

COST OF ENERGY TO SEVERAL ELECTRICAL SUPPLY SYSTEMS, IN CENTS PER KILOWATT HOUR.

A tabular recapitulation of the data for the several systems.

The foregoing data show how impossible it is to lay down any fixed rule for the fixed cost of energy in systems of electrical supply, because of variations in other factors as well as size. No doubt it can be demonstrated by figures that systems with the annual outputs named might deliver energy at lower costs. The only merit claimed for the present data is that they accurately represent results actually reached in practical electrical supply.



THE STARTING POINT OF THE NATAL GOVERNMENT RAILWAYS AT DURBAN.

# THE RAILWAY SYSTEM OF NATAL.

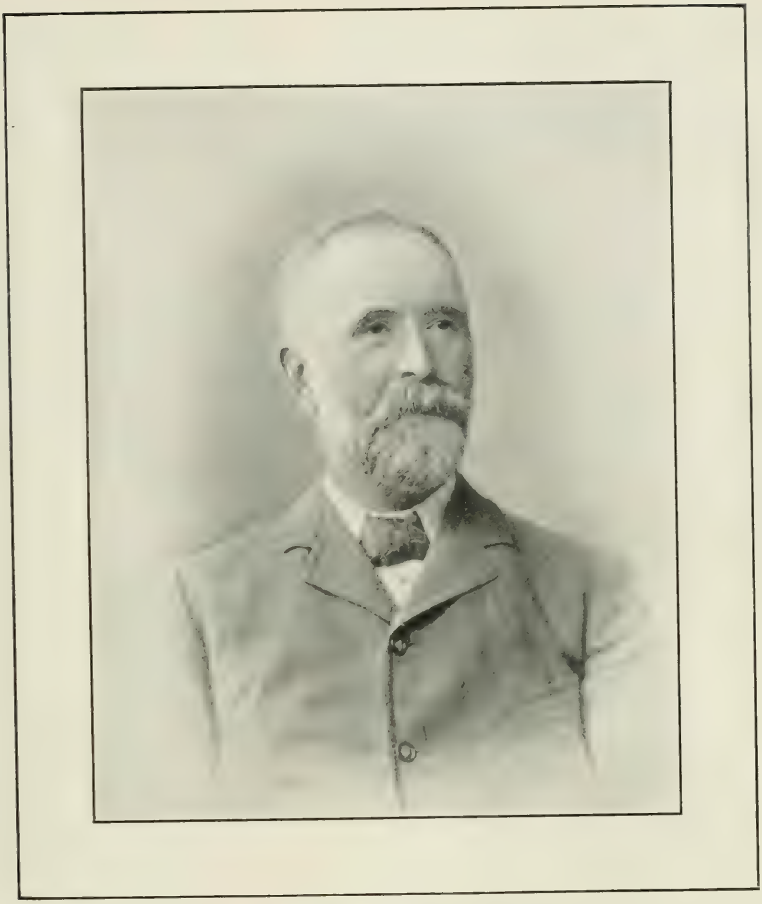
## A SPECIAL INTERVIEW WITH THE HON. SIR DAVID HUNTER, K.C.M.G., GENERAL MANAGER OF THE NATAL GOVERNMENT RAILWAYS.

*By J. Hartley Knight.*

There are two important factors likely to influence the development of South African railways. First stands the lately reported discovery of new gold areas, rivalling in size and importance the already known reefs. Second is the possibility mentioned by Mr. John Hays Hammond in these pages in July last—that with irrigation the Transvaal would become highly fertile. It is not inconceivable that, as in the case of California, the movement of agricultural products might in the end exceed in traffic importance the railway business provided by the mines. In any case, the railways of Natal seem certain of great activity and expansion during the next few years, and this gives interest and importance to Sir David Hunter's views as obtained and recorded by Mr. Knight.—The Editors.

"So long as we make and manage the railways I care not who makes the law," observed the general manager of the Natal Government Railways—Sir David Hunter—when presiding, in 1897, at an important conference of the executive heads of the South African railway systems. The remark is not only characteristic of Natal's "Railway King," but it also illustrates the spirit which the leading men of the Garden Colony have ever displayed in their determination to advance and uphold the interests of their portion of the great sub-continent, and which has made their colony a model of its kind to the rest of "Darkest Africa." There is no gainsaying the fact that for its size the colony has shown a wonderful amount of enterprise in all that pertains to the progress and welfare of its people; and it must never be forgotten that the iron horse made its first appearance in Africa on the hospitable shore of fair Natal. Of that important fact, indeed, Natalians are not a little proud, and naturally so. Forty-five years have elapsed since certain far-seeing men of Natal came to the conclusion that a railway was essential to the welfare of their colony, and three years later, in 1860, the shrill whistle of the locomotive was heard for the first time in Durban, or, as it was then more generally termed, Port Natal. The line was—like the immortal Jack Easy's wet nurse's baby—"a very little one." To be exact, it was less than two miles in length and it ran from the Point—situated at the base of that bold headland locally known as the Bluff—to the town of Durban. The line was constructed and run by the Natal Railway Company; and I am indebted to Mr. J. Forsyth Ingram for the statement that it was worked under difficulties "which can scarcely be realised at the present time." Some years elapsed before the Point Line began to show a margin of profit. It is interesting at this length of time to recall that for the half-year ending December 31st, 1868, the liabilities of the Natal Railway Company were returned at £13,695 14s. 5d., that their gross revenue amounted to £3,815 1s. 7d., and their gross expenditure to £3,005 1s. 1d., showing a net profit of £810 0s. 6d. Thereafter, as the liabilities of the company decreased, the revenue and profits rose in proportion, and in the half-yearly report to the 31st December, 1874, we find the following results: Liabilities, £2.389 11s. 4d.; gross revenue, £11,116 15s. 2d.; gross expenditure, £6,499 10s. 7d.; net profits, £4,617 4s. 7d. To have made a profit of less than £5,000 after 14 years' working is not perhaps a cause for very much trumpeting—but be it remembered that the line whence this profit was derived was only two miles in length and was after all little more than a toy, though it served a very useful purpose.

Evidently the difficulties which Mr. Ingram hints at were to some extent responsible for the fact that so long a time went by before a start was made to metal the distance which intervened between Durban and Pietermaritzburg, the capital, a matter of 71 miles. That a railway between the two towns was badly needed there is abundant evidence to prove. The first sod of the new extension was ceremoniously "turned" in 1876—that is, 16 years after the opening of the line from the Point to Durban. Amid a tremendous burst of cheering "the sod



SIR DAVID HUNTER, K. C. M. G.
General Manager Natal Government Railways.

was cut and turned and trundled and finally pitched out of the new barrow back again upon the dusty soil, all in the most artistic and satisfactory condition."

Some three years after this auspicious occasion there proceeded to South Africa a young man who had shown such marked ability as assistant general superintendent of the North British Railway that the then Secretary of State for the Colonies in the British Cabinet appointed him general manager of the Natal Government Railways, which had absorbed (as will presently be told) the Natal Railway Company. The British ministers who have successively "bossed" the colonies from Downing Street have occasionally displayed a lament-

THE MAIN WHARF, DURBAN, LOOKING NORTH.

able ignorance of the requirements of their oversea *protégés*, but it is to the eternal credit of Sir Michael Hicks-Beach that he gauged the necessities of Natal and sent the colonists the right man in the person of Mr. David Hunter to look after their railway affairs. It is not flattery but simply the honest plain truth to say that Sir David Hunter has made the railway system of Natal what it is to-day, viz., a model for other colonies to emulate, if not to equal. Quite recently—on the day before the Coronation solemnity in Westminster Abbey, whereof he and Lady Hunter were honoured spectators—I had the special privilege of discussing Natal railway matters with the gentleman who so largely controls them. I desire at this stage to express my great obligations to Sir David Hunter for so courteously and good-naturedly consenting to be interviewed at a time when he obviously needed rest after a long and fatiguing night journey by train from Edinburgh, to which city he returned almost immediately after the ceremony in the Abbey, there to enjoy the remainder of the holiday granted him after the immense strain which was imposed upon him in Natal during the recent Boer campaign. I found it hard to induce Sir David Hunter to talk about himself; instead, he preferred to speak of the Natal Railway system. To a large extent the two subjects are synonymous.

"I first went to Natal in 1879," said Sir David, "having been appointed, as perhaps you know, by the gentleman who was at that time Secretary of State for the Colonies. This was a couple of years after the Natal Government had acquired from the Natal Railway Company the line from the Point to Durban—which had been running for some years—and thence to Umgeni, about five miles altogether. The Natal Government had taken up the question of railway construction in real earnest. The first railways constructed under their direction consisted of a line from Durban to Maritzburg, another from Durban to Verulam (20 miles) and a third, of only 7 or 8 miles, from Durban to Isipingo, on the South coast—in all about 100 miles. The construction of these lines was commenced simultaneously. The line to Maritzburg was completed in 1880 and the opening ceremony was performed at Maritzburg Station by the then Governor, Sir George Pomeroy Colley, who was afterwards killed at Majuba in the first Boer war."

A RIVER CROSSING IN NATAL.

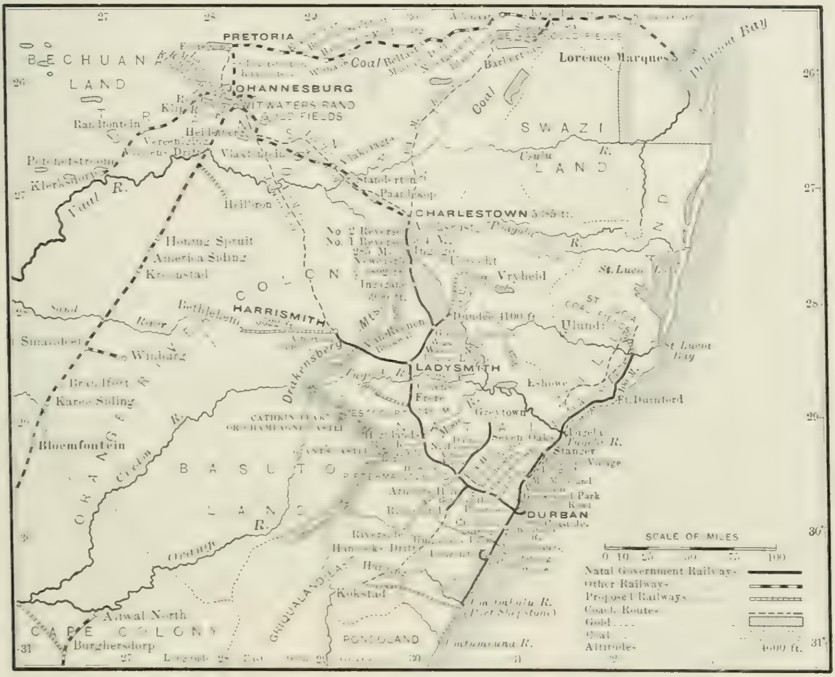
"The arrival of the iron horse in Maritzburg was doubtless an incentive, Sir David, to go ahead with railway extension in other directions?"

"It was. After the line to the capital was in working order fresh railway extension was projected, and the next section beyond Maritzburg, in a northerly direction was commenced. Howick and Estcourt were reached and the line ultimately stopped at Ladysmith. The wark of extension beyond Ladysmith was performed in a somewhat fragmentary fashion, if I may so express it, governed by the financial circumstances of the Colony. The first section was one of 17 miles and extended to the now historic field of Elandslaagte. It was afterwards extended to Glencoe junction—whence a branch line goes to Dundee—and subsequently to Charlestown, the most northerly point of Natal. The line to Charlestown was opened for traffic in 1890 in the presence of Sir Charles Mitchell, then Governor of Natal (after whom the little border town was named), who was attended by the members of the Executive Council, of which at that time I was one. There were great rejoicings on that occasion. His Excellency met President Krüger at Borderspruit, that is to say in Transvaal territory, and the old gentleman"—I acquit Sir David of any sinister intention in the term—"was accompanied by a large number of his principal officers. The whole company were conducted to Newcastle and to Maritzburg and, later on, to Durban, where great festivities were held. You may

THE RAILWAY STATION AT MARITZBURG.

be interested to know that on that occasion it fell to my lot to present 'first' tickets—which were numbered 0000 as 'first' tickets usually are —to Sir Charles Mitchell and to Mr. Krüger, a 'single' to the former and a 'return' to the latter. These tickets were of gold and the back of each bore a suitable inscription.

"But this completion of the Natal line to Charlestown did not mean through connection with Johannesburg. The extension of the line from the Natal border to the Rand is a long story, and was not accomplished until after much wearisome discussion with President Krüger in Pretoria, in which I was always one of the delegates. In the first instance I accompanied Mr. F. Seymour Haden, C.M.G. (Colonial Secretary of Natal), but on the two subsequent occasions my colleague was Mr. (now Sir) Thomas Murray, then Minister of Lands and Works under Responsible Government. The conference took place as I have said in Pretoria and on the last occasion we made a stay there of several weeks." [Sir David did not add that Mr. Krüger, like Pharaoh of old, had hardened his heart to the delegates' representations so persistently that their souls almost sickened at his stubborn-



NATAL GOVERNMENT RAILWAYS AND CONNECTING LINES.

HYDRAULIC CRANES AT WORK ON THE MAIN WHARF, DURBAN.

ness, but it is a fact nevertheless.] "At last, however, we came to terms with the President and on February 3d, 1894, we entered into an agreement with him whereby we undertook to extend the line from our border to Johannesburg. The extension was completed and the line opened for traffic in October, 1895. It is a fact that the actual construction of the line in the Transvaal was carried out by the Government of Natal, the general manager (that is, myself) representing them as the contractor for the work, and the agreement being signed by myself and the chief engineer of the Netherlands-South African Railway Company. When the rails were joined up at Heidelberg there was a formal gathering followed by a luncheon, at which were present Doctor Leyds, representing President Krüger, and Sir John Robinson, the first Premier of Natal. During the latter's term of office, a new departure took place in the construction of cheaper railways than the main line—although still adhering to the standard gauge of three feet six inches—and extension took place both on the north and south-coast routes, the former ultimately reaching the Tugela River and thence running for another 100 miles to the St. Lucia coal fields in Zululand which is now, as you know, a province of Natal. On June 30th last the rails of this line were within 15 miles of a terminus at St. Lucia Bay, and on the 20th of July about 50 miles of the line were formally opened for traffic.

"There is hardly any doubt that this extension will be of great assistance to the development of Zululand. As I have said, about 100 miles in all are being constructed in Zululand, and these will form a very great feature in the opening up of the country, which has hitherto been almost entirely a black-man's land but will no doubt be opened to European settlement. On the south coast of Natal the line has been extended to Port Shepstone on the banks of the Umzimkulu River, about 70 miles from Durban. From the Umzimkulu it is proposed to construct a line towards Kokstad and North Pondoland."*

"Then there is the line which will directly connect Natal with the Cape Colony—how does that stand, Sir David?"

"The extension from Maritzburg to Riverside has already been commenced. It consists (so far as the Natal portion is concerned) of about 100 miles of railway, and already some 25 miles are under construction. The Cape, although pledged to undertake this connection, has not yet taken the necessary steps—in so far, that is, as actual construction is concerned."†

Whilst on the subject of railway extension I desired to elicit from Sir David Hunter some expression of opinion on the big undertaking which is shortly to engage the attention of a special session of the Natal Legislature, viz., the doubling of the existing main line to Johannesburg or the construction of a new alternative route thereto. Sir David, however, could not yet say which of the two schemes was, in his opinion, the better one, explaining that extensive surveys are now going on, the result of which is not yet known; and I passed on to the subject of the engineering difficulties which had presented themselves in the construction of the existing lines.

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* The total mileage now open in the colony is 660—about 140 miles more are under construction and, as indicated, a number of other extensions are in progress.—J. H. K.

† A Reuter's telegram, dated Durban, Aug. 3, says:—"Capital progress is being made with the construction of the Cape Natal Railway. The route has been pegged out as far as Umkomaas, and several survey parties are at work. Some of the country through which the line passes is of a most difficult character."—J. H. K.

ELECTRICAL POWER HOUSE ON THE UMOOTI RIVER.

Connected with the tea factory on the Kearshey Estate.

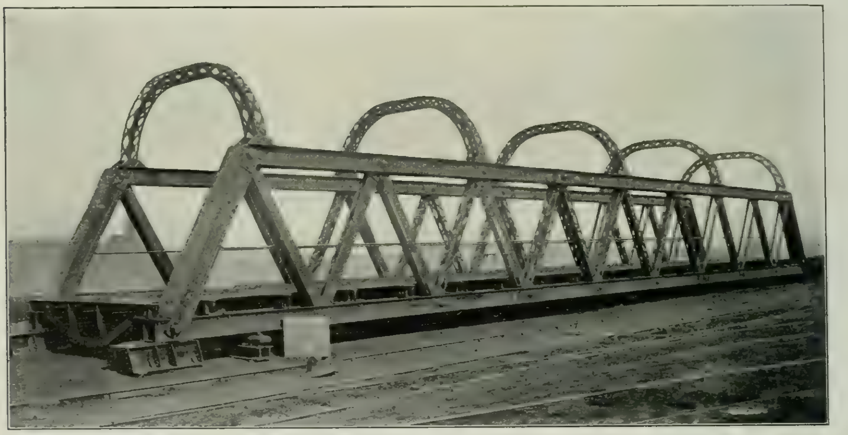
Natal is a very beautiful country and has every claim to the proud title of "the Garden Colony"; few, I think, will dispute that. But from the engineering standpoint it presents difficulties which are if not absolutely insuperable, at least not easily surmounted. The history of the recent Boer war has made that fact pretty common knowledge by now, I fancy. Quoth Lady Barker in reference to the extension from Durban to Maritzburg: "How the railway is to drag itself up and round all these thousand and one spurs running into each other, with no distinct valley or flat between, is best known to the engineers and surveyors who have declared it practicable. To the non-professional eye it seems not only difficult, but impossible." There we have the matter in a nutshell, so to speak; and a glance at the map on page 193 will show that railway construction in Natal is largely composed of gradients, and gradients, and again gradients—with now and again a magnificent curve of really appalling radius. A man in South Africa once told me that they dare not run long trains in Natal lest the heads and the tails thereof should collide with each other when negotiating the curves say, between Durban and Maritzburg. How steep are the gradients will be gathered from the statement that the main line reaches an altitude of 3,054 feet above sea level at a point 58 miles distant from Durban, and that at a point 134 miles from that seaport it rises to a height of 5,152 feet, only to drop again another 55 miles further on to 3,284 feet. At Charlestown, in the extreme north of Natal, the altitude is 5,380 feet; and at Van Reenan, in the Drakensberg Mountains, where the line passes from Ladysmith to Harrismith (in the sometime Orange Free State) the line rises to a height of 5,520 feet.

"From the uneven character of the country," observed Sir David Hunter, when I raised the point, "Natal presents many difficulties in railway construction, and the earlier policy (when the colony was poorer than it is now) consisted of constructing lines over practically the contour of the country and the adoption of very severe gradients. The ruling gradient of the first section of the Natal line was 1 in 30, with curves of 300-feet radius. It is not seldom that these conditions are found in combination. As the result of experience and better circumstances the colony is now trying, although at greater first cost, to construct lines with easier gradients, and the newly constructed lines

REVERSING POINTS ON THE DRAKENSBERG MOUNTAINS.

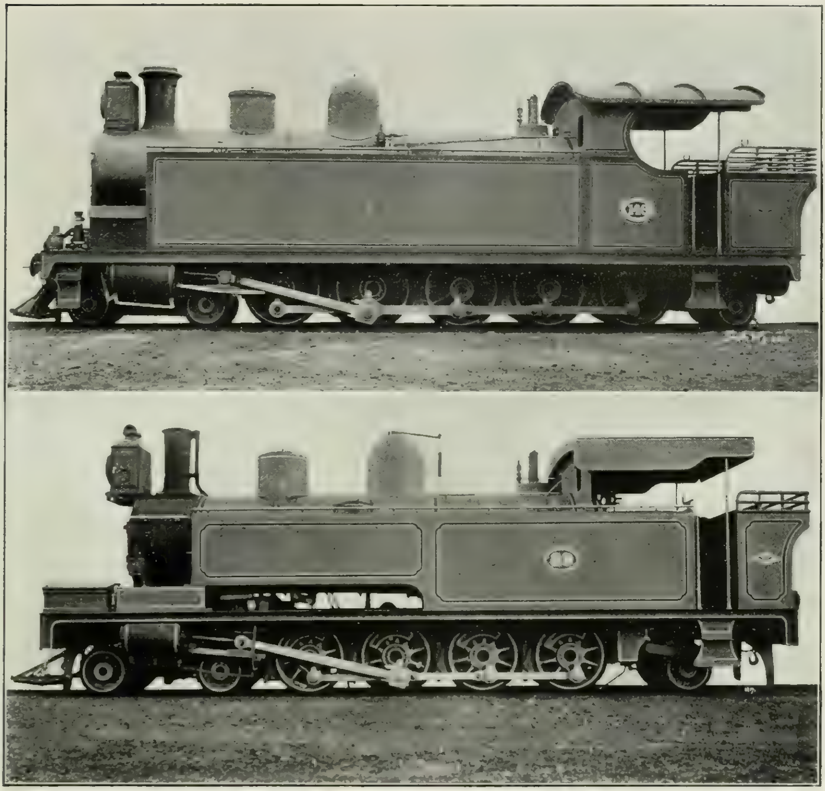
in the vicinity of Ladysmith have a gradient of 1 in 50. In regard to the matter you mentioned just now, viz., the doubling of the present main line to Johannesburg or the laying of an alternative rail from the coast, account will be taken of the existing conditions as to gradients, so as to obtain railways having better physical advantages, in order that the colony may be enabled to work the expected large through traffic to the Rand more economically than is at all possible under the present severe conditions.

"One special feature of the Natal railways coastwards is the very large proportion of iron bridges. This is occasioned by the number of rivers which flow into the Indian Ocean, most of which have lagoon mouths that close up during our winter and are crossed—often at very considerable length—by screw-pile iron bridges. This particular form of bridge was introduced at the time of the first construction by Mr. M. W. Carr, then engineer-in-chief of the Natal Government Railways, and it has been found to answer very satisfactorily. As a point of interest I may mention that on the South Coast line of 70 miles there are, I think, something like five miles of screw-pile iron bridges."



100-FOOT BRIDGE SPAN FOR THE NATAL GOVERNMENT RAILWAYS.
Erected by the Patent Shaft & Axletree Co., Ltd., Wednesbury, 1890.

I next broached the subject of rolling-stock. To understand what follows "without prejudice" the American reader should be told that Natal is perhaps more British in its sympathy and sentiment than any other colony on the entire African continent. Three-fourths of the white folk in Natal glory in the fact that they are of British origin, and they are resolved, as far as in them lies, to foster trade with Great Britain and Great Britain's colonies, to the exclusion, of course, of foreign competitors. But it is only fair to state that notwithstanding



LOCOMOTIVES OF THE NATAL GOVERNMENT RAILWAYS.

The lower one is the "Dubs" engine, eight-wheel coupled, weighing 48 tons in running order; the upper is the latest type of "Reid" pattern, ten-wheel coupled, weighing 73 tons.

this patriotism the average Natalian is able, like Shakespeare's Beatrice, to "see a church by daylight" and he never lets his pocket suffer—seriously so, that is—at the expense of his patriotism. In a word, he realises as Mr. Joseph Baynes, C.M.G. (a member of the Natal Legislative Assembly),* lately remarked to me, that "business as business knows no philanthropy—business as business knows no patriotism." That admirably expresses the attitude of the average Natalian.

"All our material has been obtained from British manufacturers," said Sir David Hunter. "It is rather an interesting fact that the railway system of Natal is equipped in every particular with motive-power and rolling-stock of British manufacture. We have never tried American locomotives; we have adhered to our own types, which have always been followed out in a progressive spirit. The original engines on our railway system were 25 tons weight and were capable of conveying over the steepest grade only 30 tons of paying load. The latest development is the 'Reid' engine, which weighs 69 tons, has ten coupled wheels, carries 3½ tons of fuel, and conveys over the steepest grade 120 tons of paying load. In this connection," Sir David Hunter added, "I have just been reading in the English press what one of the Metropolitan companies is doing to obtain a locomotive which will start and stop more quickly their suburban trains, and it is rather noticeable that the features of the locomotives adopted with that view are those which the Natal authorities are using and which were only adopted by them after a great deal of inquiry and experiment to secure the greatest amount of adhesion and tractive powers. It is, I may add, the heaviest engine on a 3 foot 6 inch gauge in the world."

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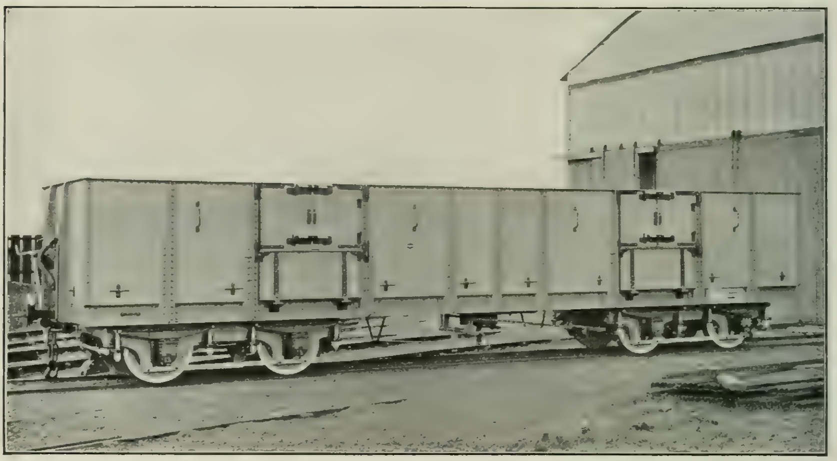
* And an earnest advocate for the general extension of light railways in Natal.—J. H. K.



HIGH-SIDED 30-TON TRUCK, NOW BEING SUPPLIED.
By R. Y. Pickering & Co., Ltd., Wishaw.

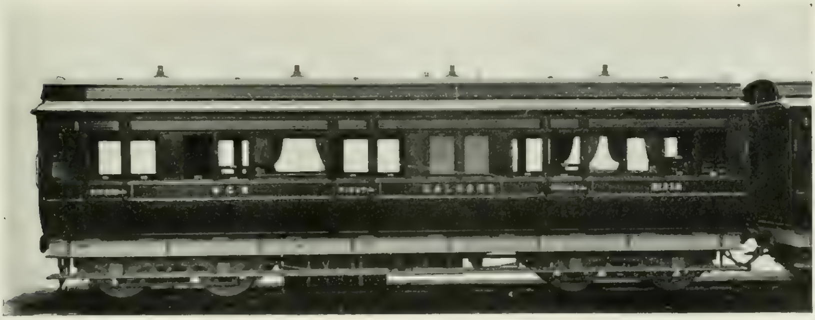
"Harking back a moment, Sir David, to the subject of American locomotives. You have no prejudice against them in Natal?"

"Oh, not in the least. With us in Natal it is not a matter of prejudice or even of sentiment, but simply that we as practical railway men have thought it better to advance along the lines of our existing types of engines, and we have achieved splendid results in this way."

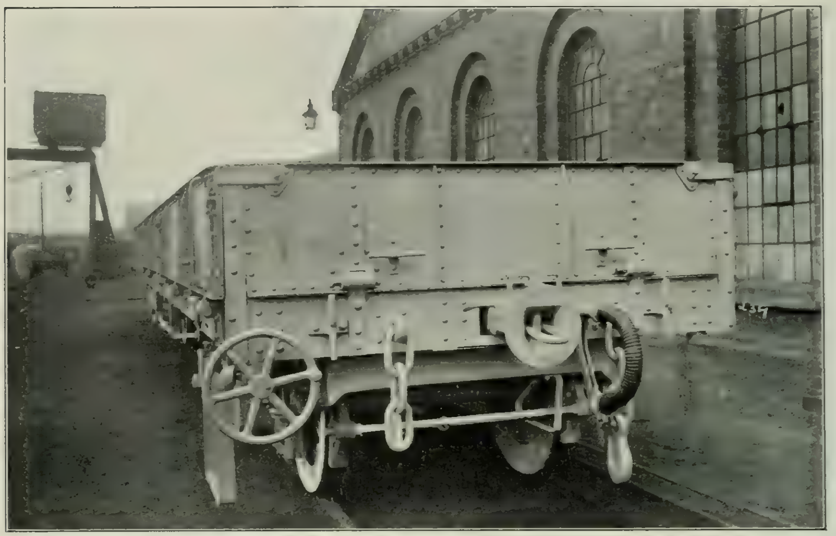
"It is open to American firms to tender for your rolling-stock as well as any other firms?"

"Certainly. We put out indents in the hands of Sir Walter Peace, the agent-general in London here, and he invites tenders in the usual way. Now and again, it is true, in times of pressure we have ordered engines direct of firms which had previously supplied us with these —but these have been exceptional instances. There is nothing to prevent American firms from tendering in the ordinary way."

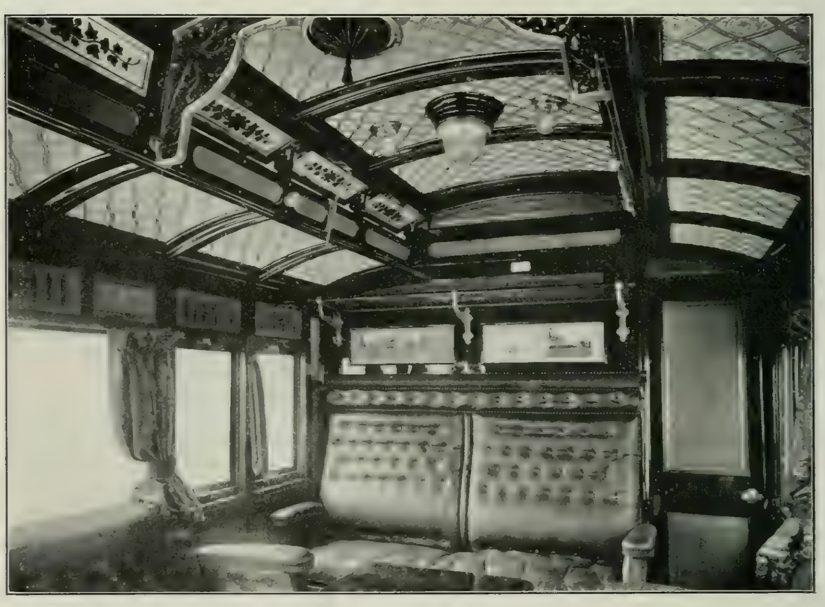
I find I have exceeded the limit to which this article should run and I must necessarily curtail what still remains to be written. In my opening remarks I have quoted statistics showing the earnings of the Natal railway in its early stage of existence. For the purposes of comparison it is interesting to recall that the total revenue for the year 1901 amounted to £1,650,355 5s. 4d., as against £1,242,280 15s. 9d., for the preceding year, showing an increase of 32.85 per cent. in comparison. In his last-issued annual report Sir David Hunter tells us that the working expenditure of the year (1901) amounted to £1,159,026 7s. 9d., "being an increase of 30.07 per cent. as compared with the preceding year, and includes £159,327 18s. 11d. expended upon additions and improvements which have been made to buildings, ways, and works, in order to cope more efficiently with traffic developments." The net revenue, after deduction of the working expenditure as explained, amounts to £491,328 17s. 7d., which, upon the capital applicable to open lines for the year of £8,528,989 gives a return equal to £5 15s. 2½d. per cent., as against £4 9s. 11½d. per cent. earned upon the capital of the former year. In this report Sir David Hunter refers in graceful terms to the retirement of Mr. M. W. Carr, M. I. C. E., after 26 years' service, the last five of which were spent in London in the capacity of consulting engineer. Sir David expresses his "deep sense of the important services rendered to the colony by Mr. Carr in the construction and development of our railway system." Mr. Carr's place in London, by-the-bye, has been taken by his friend, Mr. H. G. Humby, M. I. C. E., who has seen many years' service in the Garden Colony, and who is eminently qualified to fill so responsible a position.



SALOON CARRIAGES IN USE ON NATAL GOVERNMENT RAILWAYS.
Bristol Wagon and Carriage Works Co., Limited.

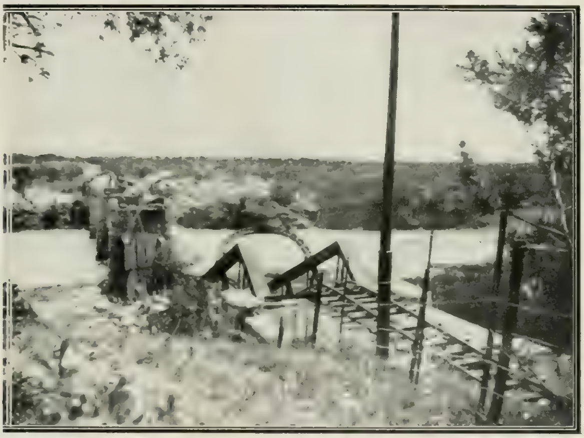


20-TON TRUCK. WEIGHT $9\frac{1}{4}$ TONS. IN SERVICE ON NATAL RAILWAYS.
Birmingham Railway Carriage & Wagon Co., Ltd.



INTERIOR OF SALOON CARRIAGE, NATAL GOVERNMENT RAILWAY.
Supplied by the Bristol Wagon & Carriage Co.

Natal's services to the Imperial cause during the campaign now happily ended will go down to posterity as one of the brightest features of a truly lamentable war. Never before had Sir David Hunter such a chance of proving the grit of the splendid fellows he controls. The late Major-General Penn-Symons, Lieut.-General Sir George White, General Sir Redvers Buller, Earl Roberts and Viscount Kitchener have successively borne high testimony to the excellence of the arrangements for the handling of the enormous traffic on the Natal lines during a period unique in the history of any country in the world.



DESTROYED BRIDGE OVER THE TUGELA RIVER AT COLENSO.

**Illustrating some of the difficulties of railway management on the Natal lines during the Boer war.**

Very heavy indeed was the demand made upon the Natal reconstruction department, but they answered to the call with a promptitude which is beyond praise, and which many an old Anglo-African of my acquaintance has declared was possible only in Natal, and which certainly was worthy of the colony which first had the honour of introducing the iron horse into Africa. No wonder Lord Kitchener in a recent dispatch acknowledges "with gratitude" the obligations under which the army in South Africa have been placed by the "ungrudging assistance" given to his lordship by, among others, "Sir David Hunter, K.C.M.G., and the staff of the Natal Government Railways."

# THE UTILISATION OF THE PEAT FUELS OF EUROPE.

*By Adolf Dal.*

While primarily of importance in countries where the cost of labour is low and the necessity for economy is acute, the use of peat is not without its industrial significance. It is reported that even in the eastern United States, resort has recently been had to peat fuel under pressure of famine prices for coal. The suggestion of its more extended use by the establishment of a power plant close to the source of supply, with power-distribution thence by means of fuel gas or electricity, is particularly interesting and in direct line with the best modern practice in the economical utilisation of natural resources.—THE EDITORS.

PEAT has long been used as fuel; in Germany especially its use dates back so far that the ancient Roman naturalist, Pliny, tells us that that Teutonic tribe on the borders of the North Sea dried and burned "mud" (peat). Its more extensive use dates from the middle of the last century, when fuel for steam engines was required on a larger scale; and in very late years, high prices of coal have attracted renewed and most active attention to the use of peat fuel.

The bogs in which peat is contained cover extensive areas in the northern temperate latitudes, both in Europe and in America. In Germany they cover nearly 30,000 square kilometres, and in Ireland, according to Lyell, they cover the tenth part of the country. The depth is very variable, but is on an average 5 to 7 metres and more; thus in Ireland bogs are found with a depth as great even as 15 metres. It may be estimated that one square kilometre of 5 metres depth will give about 700,000 metric tons of dried peat; hence it will be seen that the amount of fuel in these bogs is enormous.

Peat is all organic matter, formed from mosses and other minor plants, which have been submerged in water and thus preserved in the bogs. As it exists in the bogs, the largest constituent is water, dry matter forming only about 10 per cent. of the total weight. When peat from the bogs is used for fuel, therefore, much water must be removed and this forms a great difficulty in the manufacturing. In fact, the drying of the peat is everywhere regarded as the most troublesome point, for it is impossible to remove the water economically in any artificial way, either by pressure or by heating in kilns or kiln-like

PEAT-MILLING MACHINE AT WORK ON THE MOORS OF OLDENBURG.

appliances; the peat must be dried in the open air, and the preparation thus becomes much dependent on the climate. In level open countries, however, where the wind is constantly blowing, the the drying in ordinary years will be very well performed. In almost all districts the peat is spread out to dry in the open on the levelled and evened surface of the bog; only in certain very rainy countries, as in southern Bavaria, Styria, and in western Norway, shelters are sometimes used. Peat dried in the air will hold about 20 per cent. of water.

The most ancient method of digging peat, still much used, is the simple one of cutting it by hand with a spade in regular, rectangular pieces, which are then spread on the levelled surface of the bog and dried. At present this method is much used in the Netherlands and in Germany. Although it requires much labour, yet it will often give a very cheap fuel, especially where wages are low, a skilled labourer being able to work one metric ton of dried peat in a day. Probably the larger part of the peat produced in the countries just named is such "cut peat." But as wages grow higher this method will tend to fall into disuse.

Cut peat, however, is of somewhat loose consistence and has an excessively large bulk, a hectolitre of it weighing on an average 20 kilogrammes (12 pounds to the cubic foot). As it takes two pounds of peat to equal one pound of ordinary coals, it will be seen that eight cubic feet of cut peat must be used to equal one cubic foot of coals. Hence it follows that transportation will be costly, and store houses and fire rooms must be very large where this peat is used.

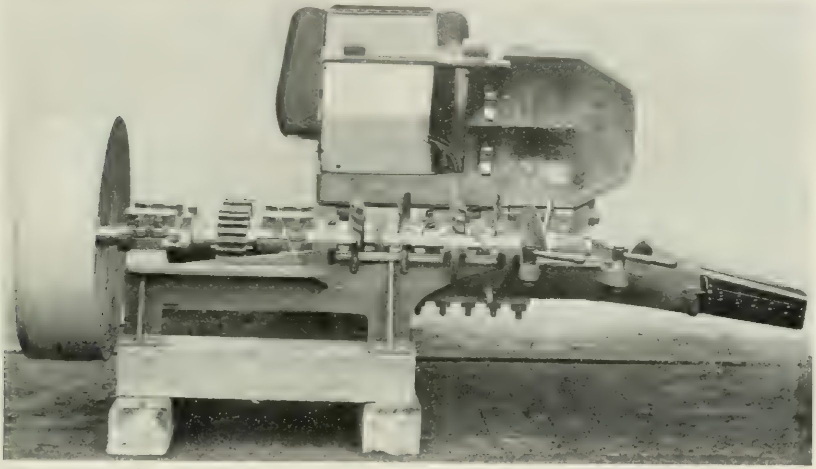
In order to reduce the volume, peat-milling machines have been commonly introduced into all European countries within the last fifty years. In these machines the fibrous structure of the peat is broken up, the mass kneaded, mixed, and somewhat pressed together; it contracts considerably in drying, the volume of the dried peat often being only one-eighth of the original. Thus the peat gains a very compact consistence, and bears a close resemblance to lignite, both in appearance and density. The specific gravity often surpasses that of water; most commonly its weight is about 40 kilogrammes per hectolitre (30 to 40 pounds to the cubic foot). In this form the peat may be transported, its weight giving a full waggon load. Nor is the machine-made peat so hygroscopic as the cut peat; it may be easily stored without absorbing water. When dried in the air it contains 15 to 25 per cent. of water.

Most of these machines knead the peat as it is taken from the bog. The machines thus used consist of a hollow cast-iron cylinder or cone, in which rotate one or two rollers set with knives or screw ridges, which break up the peat, mix it, and lastly press it through a mouth piece, which it leaves in the form of a continuous rectangular block. This block is wet and soft as the peat in its natural state, and is cut in pieces at proper lengths and then carried off to dry. Peat made in this manner is often called on the Continent, "compressed peat" (in German, *presstorf*), but it is evident that the pressure has been very slight; no water has been pressed from it, and its chemical composition has not changed; the only change is the increased density.

The first of these machines were constructed in 1861 by C. Schlickeysn in Berlin, and though since then modified in various respects, they are still on the whole much like the original model. The most modern and most improved are those from the Munktells factory at Eskilstuna in Sweden, constructed by the Swedish engineer Aleph Anrys. Several hundred of these machines are in use in Sweden and especially in Russia. On the large bogs of the latter country, often up to 20,000 acres in extent, 50 to 70 machines of this kind may be seen at work. Each machine is worked by a locomobile of 12 horse-power and employs 30 labourers, the daily output being 40 to 60 metric tons of peat in the dry state. The working costs are about 3 shillings 4 pence (80 cents) per metric ton of dried peat, the wages of the labourers being about one dollar (in Sweden).

In Germany most of the peat-pressing machines are made by R. Dolberg in Rostock and by A. Heinen in Oldenburg. All these machines are much alike in their construction. The peat is dug from the bog with the spade and filled into an elevator, which carries it into the milling machine. Much hand work and many labourers are thus required for these machines, but they are able to handle 1½ to 2 tons of peat per man per day.

Improvements may be made in these European peat factories, especially by replacing the individual locomobiles at each machine by a central power plant, and transmitting power to an electric motor for each peat presser. The digging and carrying away of the peat, which is everywhere performed by labourers, ought also to be done by electric power. Costs would then be much reduced where wages are high.



ANRYS' PEAT-MILLING MACHINE OPENED TO SHOW CONSTRUCTION.

Digging and cutting machines, both for hand and steam working, are used in eastern Germany and in the Netherlands, but only where the bogs are so wet and swampy that the water may not be drained away and cutting by hand in ordinary manner is consequently impossible. Most of these cutting machines are made by Dolberg in Rostock. They are used floating on prams or standing on rails on the bogs. The peat dug out is then immediately carried to the milling machines, but may also be used as ordinary cut peat. In the Netherlands one single manufacturer by this method makes in a summer nearly 100,000 metric tons of dried peat, all of which is sold in Amsterdam, the selling price being about 18 shillings ($4.30) per ton. The Dutch burn peat in place of coal in their stoves, hence the high prices.

In some places the peat is milled together with water, and the half-liquid mixture is then moulded in forms like bricks. This method is used in the Netherlands and to some extent in Sweden, but has been worked out more particularly in Denmark. In that country one of the best planned peat factories in Europe is to be seen at the little railway station Sparkjer in Jutland. The operations performed there are rather different from those in other places and will prove advantageous everywhere they may be used. The milling machinery is not, as in other peat factories, placed on the bog itself, but on the flat and sandy land immediately at the shore; the peat is carried up to the mill by a locomotive. The mill is driven by a stationary 12-horse-power steam engine and is of very simple construction, consisting only of a rectangular box 13 metres in length, in which rotates a roller set with knives that will break up the peat and mix it with water. The roller makes about 60 revolutions per minute. In this manner the peat is got into a semi-liquid state; it is then carried on rails by horses to the drying plain, where it is moulded into forms. The drying plain is situated on the flat and sandy land surrounding the bog; the same drying plain is thus used three or four times during the summer season.

ANRY'S PEAT-MILLING MACHINE AT WORK AT STAFSJO, SWEDEN.

Sixty-five metric tons per day of dried peat are thus made by 20 labourers, giving an output of more than 3 tons for each man. The costs of production amount to less than two-and-sixpence (60 cents) per metric ton, the wages being about 5 shillings 6 pence ($1.33) a day. In the figures of costs of the peat given here and elsewhere, amortisations are not included; but as these are rather small, they will not tend to increase costs substantially. The whole installation at Sparkjer, with exception of the bog, cost about $9,000; as the peat is sold on the place at a price of 7 shillings ($1.75) per ton, it is seen that there will be a good margin of profit.

In the peat factory at Sparkjer, some floating peat mills are also used. The milling machinery, together with a 2-horse-power gasoline motor, is mounted on a pram floating in the turf pit. At these small plants four labourers will make 13 tons of dried peat per day. Costs are even smaller than the above, not exceeding 51 cents per metric ton. Throughout Europe machine-made peat is nowhere produced at so small cost. The inventor of the appliances at Sparkjer is the Danish captain of horse Rahbek.

For a long time much attention has been given to the coking of peat in order to get a substitute for wood charcoal and for coke, the charcoal of peat ranging between these two. Formerly peat-coke was used in several places in Germany and in Austria for metallurgical purposes, and many different methods and various kilns have been proposed and used for the coking, all of which have proved more or less unsuitable for the purpose, uneconomical, and upon the whole unsuccessful, the peat coke being too costly to compete with coke from coal. In Europe, therefore, there was for many years only one factory for peat-coking, but in the last two years one or two more have been established. A plant with five kilns, according to the method of Dr. Ziegler, of Berlin, was erected in 1894 in Oldenburg, in the midst of the most extensive peat areas of Germany. In each kiln 10 to 12 metric tons of peat are coked in 24 hours, 3 tons of peat giving on an average one ton of coke. The heat in the kilns reaches 600 degrees C. (about 1,100 F.) and the coking is complete. All volatile matter is driven out and the coke burns without flame. The gases are used for the heating of the kilns, and are sufficient for that purpose and for heating in addition the boiler of a steam plant. The coke is sold at a price of 60 marks (60 shillings or $14 to $15) per metric ton, but as it is almost completely free from sulphur it is highly useful for metallurgical purposes and thus competes with wood charcoal. It is also much used by braziers and the like. Besides coke and the heating gases, the peat on coking will give tar and tar water, this being actually the case in Oldenburg, where gas, oil, sulphate of ammonium, etc., are sold as secondary products.

Dr. Ziegler has planned in Russia a coking plant for peat on the same principles as that in Oldenburg, but with the object of getting coke for locomotive use. The locomotives in Russia usually are fired with wood and mineral oils, as coal is scarce in that country, and the importation is very small. In order to be independent of foreign supply of fuel, the Russian government is trying to use peat coke for firing the locomotives, and has built a plant on the Ziegler system at Redkino on the railway between St. Petersburg and Moscow. In view of the purpose for which the coke is intended, the coking is not complete, but the fuel retains much of the bituminous matter and therefore burns with a long and bright flame, and is thus well fitted for the purpose. The yield of coke from the peat is thus increased, so that the weight obtained is half that of the peat. The success of this plant has proved good, and it is the intention to build several others in various places in Russia.

In Western Norway, near Bergen, a peat-coking plant has been built of late on somewhat different principles, the heating being effected by an electric current, taken from a waterfall in the neighbourhood. Each kiln is loaded with 400 to 500 kilograms of dried machine-made peat, and the coking takes some 3 to 4 hours. The electric current is of 500 amperes with a tension of 40 to 50 volts; the temperature in the kilns is about 300 degrees C. (570 degrees F.). The coke is rather compact and burns with a long and bright flame; it is very well suited for domestic purposes and sells in Bergen at a price of 15 shillings ($3.60) per metric ton.

In very recent years factories have been built in Europe for the briquetting* of dried peat; the briquettes are much like those of brown coal (lignite) in appearance and calorific power; they are very solid and have a fine and polished surface from the strong pressure. The peat is partly dried artificially in the factory, then crumbled, and lastly pressed in open press forms under a very heavy pressure—about 1,500 atmospheres. The press forms are open, as the friction is sufficient to produce the needed resistance. The specific gravity of the peat briquettes exceeds unity, and they have a calorific power about three-fourths that of ordinary coal. At present there are four such plants existing in Europe, viz., two in Germany, one in the Netherlands, and one in Russia, but it is to be supposed that more will be built, as the

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* For briquetting machines, *vide* also the March, 1902, issue of this Magazine.

PEAT-MILLING MACHINE ON THE OLDENBURG MOORS, GERMANY.

briquettes of peat, as well as those of lignite, are very clean to handle and thus very well fitted for household use as fuel.

Germany and the Netherlands are the native countries of peat-fuel making. In both these lands peat has been used from very ancient times, as already stated, and it is in Germany that most of the modern methods for its manufacture have been worked out. In fact, especially in Germany, much labour and much money have been spent in various unsuccessful methods of manufacture. In these countries also, peat is today very commonly used, more especially in the Netherlands. Within recent times Sweden, Denmark, and Russia have widely enlarged their peat production. In Austria, also, peat is much used in factories, especially in glass houses and brick manufactories. In Norway peat is used in the stoves in the western part of the country, where wood is scarce; but though bogs are found almost everywhere, there are no large peat factories, owing to the scanty population of this country, and to the fact that water power is obtainable in most places for industrial uses.

Apart from hand-cutting of peat, milling through machines as described is almost the only method used throughout Europe. But as the peat to fill into the machines is dug by hand, many labourers are required, and this circumstance will make peat costly where wages are high, and as these tend to increase everywhere, machinery must be constructed to dig the peat; but with the exception of very low-lying bogs where water stands on the very surface, such appliances are nowhere used as yet.

PEAT MILLING WITH HEINEN MACHINES ON THE OLDENBURG MOORS.

In northwestern Germany and in the Netherlands, peat is used chiefly as domestic fuel and, as stated above, is sold in Amsterdam at prices absolutely higher than those of coal, peat measured by its thermal effects being more than twice as costly as coal. There is no special construction of the stoves, but in Denmark a special patented device, the so-called "spit-stove" of Mr. Reck, is used for peat combustion.

In southern and eastern Germany, but above all in Russia and in Sweden, peat is used principally for industrial purposes, a great many boilers, small and large, being peat-fired. In breweries, distilleries, and under salt-pans, peat is used in Germany on a very large scale and is very advantageous for these purposes, the heat being not so intense as when coal is used. Moreover, as peat contains no sulphur, the caldrons and boilers are not subject to so much injury as when coal-fired. It is estimated that they will last three times as long as when coal is used for fuel. Boilers of any size may be heated by peat; for the larger units step-grates are the most suitable; the peat may then be fired even when rather wet, this being of importance in summers when drying is difficult and not thoroughly performed.

Ordinary peat has a thermal effect about half that of coal, the accurate proportion being as 1 :1.8. Hence it follows that the transportation of a thermal unit in peat will cost about twice as much as in coal. Establishments based upon the use of peat fuel should therefore generally be placed very near the bogs, this being actually the case in eastern Germany and in Russia. But as this is a very heavy drawback, bogs often lying apart and far from the great lines of transportation, central power plants should be erected in the middle of the large bog areas, and power transmitted electrically to places more suitable for the factories. Such power plants have not as yet been established, but it is easy to show that fuel for one horse power in such a plant, erected in the immediate vicinity of the bog will cost only 1/9 of a cent per hour.

In an article contributed by W. O. Webber to this Magazine for the issue of September, 1898, it is stated, that in the best large steam-power plants only one pound of coal is used for one horse-power hour. As one pound of ordinary coal is equal to 1.8 pounds of peat, this costing 5 shillings or $1.25 per ton, the cost of peat fuel will not exceed 1/9 of a cent per horse-power hour.

Gas from peat is used for heating purposes in several places in Europe, but most extensively in Sweden. In that country it is used for the melting of Martin steel, while in other places it is used in glass houses and the like. The generators used are of very simple construction. In a Swedish magazine, *Jernkontorets Annaler,* Rich Aakermann has given an exhaustive memoir on the use of gas for Martin-steel melting.

The peat used in Sweden for generating gas has the following composition:

| | |
|---|---|
| Carbon | 60.0 per cent. |
| Hydrogen | 6.4 " " |
| Oxygen | 31.7 " " |
| Nitrogen | 1.9 " " |

Or, if hygroscopic water and ashes be reckoned:

| | | |
|---|---|---|
| Carbon | 38.2 | per cent. |
| Hydrogen | 4.1 | “ “ |
| Oxygen | 20.2 | “ “ |
| Nitrogen | 1.2 | “ “ |
| Sulphur | 0.0 | “ “ |
| Ash | 8.6 | “ “ |
| Water (hygroscopic) | 27.7 | “ “ |

The gases have the following composition:

| | | |
|---|---|---|
| $CO_2$ | 6.9 | per cent. of volume. |
| CO | 26.0 | “ “ “ “ |
| $C_2H_4$ | 0.5 | “ “ “ “ |
| $CH_4$ | 4.4 | “ “ “ “ |
| H | 8.5 | “ “ “ “ |
| N | 53.7 | “ “ “ “ |

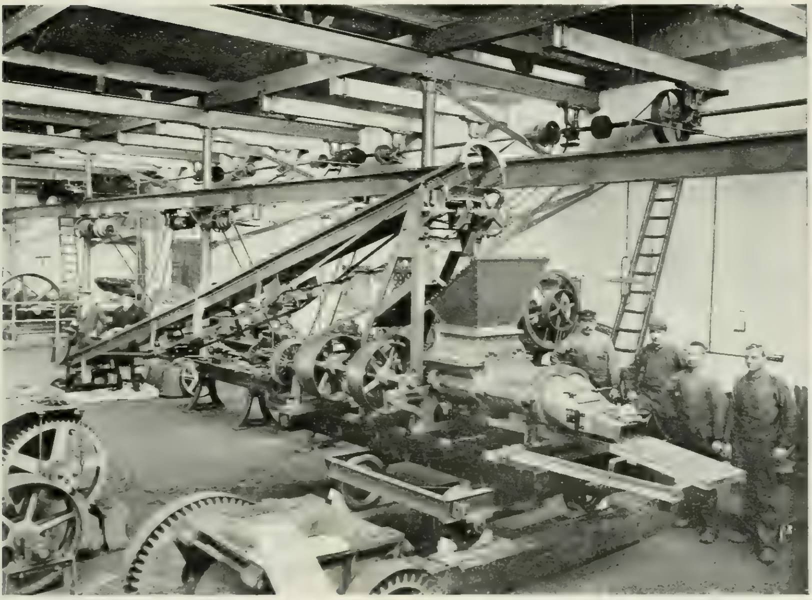
The quantity of gas obtained from 100 kilograms of peat is about 252 cubic metres. The sorts of peat here used have an excessive amount of ash and much hygroscopic water. In fact, ordinary peat will not have more than 5 per cent. of ash and when well dried in the air, it will not contain more than 20 per cent. of water; under such conditions the gas will be of much better composition.

It is not known that peat is used anywhere in Europe to produce power gas on any particularly large scale, but the results obtained of late with the Mond gas generators, where power gas is generated from slack coal with 60 per cent. of carbon, would tend to show that peat will give as good results.

In reality, there is no great difference between such slack coal with 60 per cent. of carbon and good peat, the only difference being the greater contents of water in the peat. But as two and a-half tons of water, as steam, are used in the Mond gas generators to one ton of slack coal, to regulate the process, the larger amount of water in the peat must not be considered as a drawback, but rather as tending to make the generating of steam superfluous and thus to reduce costs.

In the figures given above, showing the composition of Swedish peat gases, nitrogen is present in rather large amount. This results from unmixed air being used for the combustion in the generators; when it is properly mixed with steam and carbonic oxide the results obtained will prove better.

It is now well known that gas may be led economically to great distances, for power supply and for incandescent lamps. Thus Mond gas is piped in England from central gas works to the surrounding factories, and in Pennsylvania natural gas is piped for distances ex-

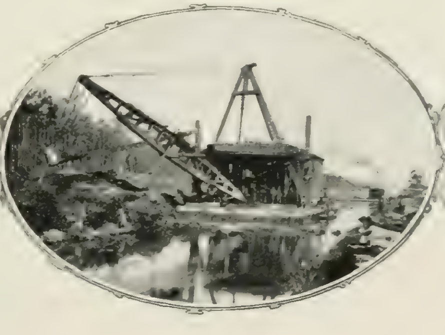


HEINEN'S WORKS FOR BUILDING PEAT-MILLING MACHINES AT VAREL, OLDENBURG, GERMANY.

ceeding 90 miles. There is no reason why gas from peat should not be used in the same manner.

It is my opinion that where the peat cannot be used in factories on the spot, it should not be transported, as costs will be nearly double those for carriage of coal; but power should be transmitted, either in the form of electricity or as peat gas—the former for long distances, the latter for shorter ones.

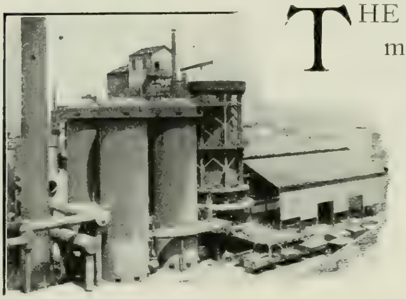
The use of peat on a larger scale than hitherto will not only prove to give cheap fuel, but the digging out of the bogs will in many cases make the countries more wholesome and the bottom of the bogs will give a fertile soil, as is seen in the Netherlands.



# PROGRESS IN INTERNAL-COMBUSTION ENGINES.

*By W. H. Booth.*

Attention has frequently been drawn in these pages to the enormous possibilities of power economy yet to be realised by the utilisation of blast-furnace gases in the internal-combustion engine. This is the direction in which the gas engine is making its most striking progress; the largest units exhibited at Düsseldorf last summer, and illustrated in these pages in October, are but half the size of the machines already under construction in the United States. But this progress follows step-by-step the advance in mechanical excellence and thermodynamic efficiency which is Mr. Booth's chief topic.—THE EDITORS.



THE progress of the gas engine, which may be termed the general representative of the whole genus of internal-combustion engines, has not been particularly rapid. Though the correct cycle of operations was indicated by Beau de Rochas in 1862, it required many years to put his clearly defined propositions into practice. Others had appreciated the necessity of compression before his time, but probably no one so clearly grasped the whole theory of the gas engine as he; for he went so far as to point out that there was a limit to the degree of compression in the spontaneous combustion that would occur at high compressions—a limit the significance of which, in reference to the future of gas engines and gas producers, has not yet been generally appreciated. Though Beau de Rochas expounded a correct theory in 1862, the best, or at least the most popular, gas engine up to about the year 1877 was the gun or free-piston engine of Otto and Langen, though in 1876 Otto had begun to build engines based on the Beau de Rochas cycle, which has since been incorrectly and unfairly called the Otto cycle. Scientific men, as a rule, have contented themselves as regards mechanical arts with fitting theories to machines laboriously elaborated by practical men groping in the dark. The practical man has had but little aid from the theorist until too late. Beau de Rochas was a decided exception to the rule, for he fully grasped the theory of the gas engine and laid down rules to which the practical man has only today signified his adherence. It required fifteen years before the Rochas cycle was taken up by Otto, and it has required forty years before the next step has become at all popular, though Beau de Rochas came perilously near to inventing the Diesel engine also.

The first practical engines, the Lenoir and the Otto and Langen, the Bischoff, and a host of others, simply drew in a charge of mixed air and gas and exploded it in the cylinder. As soon as the Otto engine with the Beau de Rochas cycle had come fairly on the market, all the previous engines disappeared. The Rochas cycle held the field and was variously modified. Atkinson, for example, brought out an engine in which the explosive charge was drawn in and compressed by a piston travel less than the travel on the explosion stroke. He thus obtained a better expansion of the exploded charge, while the longer exhaust stroke effectively scavenged the cylinder of burnt gases.

The Griffin engine had two idle revolutions, in place of one, to each explosive stroke, the extra revolution serving to give a scavenging stroke to drive out the last of the burned gases which diminish the value of the next explosion. Other inventors have aimed to secure an explosion every revolution, though still adhering to the Rochas cycle. Thus Clerk employed a separate charge-compressing pump, and Benz and others have followed on similar lines. In the Smith engine, for example, there is a free inner piston, kept apart from the main piston by a long coiled spring. This free piston is in close contact with the main piston during the explosive stroke. When the exhaust opens at the back of the cylinder, the main piston uncovers the air and gas or petrol port near the front of the cylinder. Relieved from pressure, the free piston is driven rapidly back by the spring, expelling the burned charge and drawing in the new charge which fills the space between the two pistons. The main piston now returns and forces the charge through a backward-opening valve in the free piston into the compression space, and the two pistons meet flatly face to face without any remaining charge between them. The valve in the free piston closes with a light spring and the compressed charge is exploded behind the free piston, which is now in solid contact with the main piston. The two pistons move forward as one and the cycle is repeated, an explosion being secured every revolution. The Smith engine has only been made so far in small sizes.

Many engines have been made with the exhaust port forward, the new charge being forced in at the back of the cylinder to be compressed on the return stroke in order to secure an explosive stroke each revolution. Where blast-furnace gas has been employed, air has conveniently been used from the blowing engines to give a scavenging to the cylinder, but all varieties are but variants of the Rochas cycle.

It has become daily more apparent that high rates of compression must accompany economy. Here, however, a difficulty has presented itself, more especially in petrol engines, the vapour of which is so rich in hydrogen or its carbon compounds. Hydrogenous gases are much more easily ignited than carbonic oxide, and until recently it has been widely held necessary or desirable that even producer gas should contain a percentage of hydrogen, in order that ignition should be the more easily and certainly effected. Hence the use of steam in gas producers. The steam becomes decomposed in passing through the incandescent carbon and the hydrogen appears in the gas and no doubt does facilitate ignition. All gases, however, when compressed become heated, and the point is soon reached where a combustible gas compressed in the presence of air becomes hot enough to combine with the oxygen of the air. Hence arose premature ignitions. Indeed, the trouble with illuminating gas has been so serious that many installations of electric power with gas as motive power have been condemned as failures. The presence of hydrogen has proved a bar to high compression, and the result has been that there are two camps of producer-gas men—those who, like Mr. Thwaite, demand a gas almost wholly of carbonic oxide as regards the combustible constituents, and those who advocate a proportion of hydrogen. With the present form of gas engine the former appear to be on the winning side, because they can use much higher compression without danger of early explosion and its accompanying risks. While gas engines were small these risks were of comparatively small moment, but with large engines they become much more serious, producing heavy shocks and dangerous reversals.*

Had it not been for producer gas, the progress of the gas engine in large sizes would have been small. Having grown large and fairly perfect, it is evident that petroleum affords an excellent fuel for the internal-combustion engine, but it is so readily ignited, being so highly hydrogenous, that only moderate rates of compression can be employed with safety. Finality has been attained in the principle of compression of the explosive mixture.

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* In the engine designed by Donàt Banki, and built by Ganz & Co., of Budapest, a spray of water is atomised and drawn in with the gas, this raising the igniting point of the charge to an extent permitting a high degree of compression without danger of pre-ignition. The expansion of the vapour of water returns as power the heat which it absorbs, and a high degree of economy is obtained. These engines operate well only with benzine, gasoline, and similar light fuels.

At this point a fresh inventor appears in Herr Diesel, who has advanced the gas engine to the point that appears to have been foreseen by Beau de Rochas. Recognising that there is an early limit to possible compression, but that there is economy in possible higher compression, this inventor has refused to compress the explosive mixture. He compresses air alone. By doing this apart from any combustible, he is already employing compression to 35 atmospheres or say 500 pounds per square inch. The high rate of compression renders the air exceedingly hot, so hot indeed that it will ignite any combustible brought into contact with it. Into this hot air, petroleum is injected by a small pump and it is at once ignited and by its combustion it enables the compressed gas to expand along a curve of pressure greater at any point than the pressure during compression. Hitherto liquid fuel has been employed in this engine, but there is no reason why gas should not be used. This system opens up at once a new field in gas producers. It renders possible the employment of any hydrogenous gas, for there can be no premature ignition, no fuel being admitted to the cylinder until the proper time, and then not exploding but simply burning quietly as an ordinary flame jet. There is now no limit to the intensity of compression that can be given, excepting the mechanical difficulties, which appear to be perfectly surmounted up to the above-named pressure of 35 atmospheres. There is also the question of temperature to be considered. In this respect the ordinary gas engine explodes the whole of its charge at or near the dead point, and the exploded charge is at a very high initial temperature and much heat is lost to the walls of the cylinder and to the jacket water. In the newer method the initial temperature is less. The fuel is admitted through a certain period of time, and as fast as it generates heat so fast does this heat disappear in the form of work done on the now moving piston, and also still to the jacket. But the temperature being always kept more moderate, the "head," or difference of temperature between the gases and the jacket, is less than in the explosion engine and the heat losses to the jacket are less also. Scientifically, the water jacket of the gas engine is an absurdity, only to be tolerated because we have not learned to control the temperature in the cylinder or to make a cylinder capable of working at the high temperature generated within it. We therefore surround the cylinder with a protective shell of water, knowing all the time that the principle of this is bad. The Diesel engine still requires its water jacket, but less heat is now lost to it. It is thus a step forward towards that thermodynamic perfection, the fundamentals of which were so clearly defined by Beau de Rochas forty years ago, but have been so tardily and laboriously acted upon by practical men.

Mr. Emerson Dowson, who was among the first to apply the cheap or producer gases to the driving of gas engines, has stated that a power gas should not contain less than 1,200 calories per cubic metre (135 B. T. U. per cubic foot) and that it should contain 15 per cent. of hydrogen to ensure its certain and easy ignition at the rapid frequence necessary in gas engines. The following is a characteristic analysis of a gas made in a Dowson producer.

| | | | |
|---|---|---|---|
| Hydrogen | 20 | per cent. | Proportion of air necessary for combustion, 107.5. |
| Carbonic oxide | 20 | “ | |
| Carbon dioxide | 7 | “ | |
| Nitrogen | 50 | “ | |

Calorific value, 138.4 B. T. U.
Ratio of calorific value of CO. to total, 53 per cent.

Herr Ludwig Mond produces a gas which analyses as follows:

| | | | |
|---|---|---|---|
| Hydrogen | 29 | per cent. | Proportion of air necessary for combustion, 120. |
| Carbonic oxide | 11 | “ | |
| Marsh gas | 2 | “ | |
| Carbon dioxide | 16 | “ | |
| Nitrogen | 42 | “ | |

Calorific value, 135.3 B. T. U.
Ratio of calorific value of CO. to total, 26 per cent.

In 1894 Mr. B. H. Thwaite synthesised a gas with the proportions of blast-furnace gas, and found that it worked well in gas engines and quite exploded the general opinion, theretofore held, that so poor gas was too poor to burn satisfactorily in a gas engine. The heating effect of compression and the closer approximation of the gas molecules had not before been recognised as possessing the important effects they are now discovered to possess in undesirable excess.

Mr. Thwaite expressed the opinion that hydrogen was not a desirable constituent of power gas, because in its combustion so much heat is rendered latent in the steam formed by its combustion and cannot be recovered except by recondensation to water. He stated, secondly, that a gas should be fixed and not liable to condense to a liquid form under the influence either of low temperature or of compression; also that no constituent of a power gas is desirable when a small addition or subtraction of that constituent makes a considerable difference in the calorific capacity per cubic foot. Hydrogen is particularly undesirable in the poor gases, because these require considerable compression to secure economical results and premature explosions are thus induced. If compression is kept low as a safeguard against possible variation of hydrogen and premature ignition, there is introduced the disadvantage of delayed ignition whenever the more readily ignited constituent shall happen to be present in less than normal quantity. Hence any variation of hydrogen involves danger of pre-ignition, or risk of loss should low compression be employed to avoid the danger. When hydrogen and hydrocarbons are kept within the limits laid down, the expansion curves of the indicator diagrams are remarkably steady and even and successive diagrams coincide in every line. The limit of hydrogen laid down is 3 per cent. I am indebted to Mr. Thwaite for the following analysis of his ideal gas.

| | | |
|---|---|---|
| Carbonic oxide | 30 per cent. | Proportion of air necessary for combustion, 77½. |
| Hydrogen | 1 " | |
| Carbon dioxide | 10 " | |
| Nitrogen | 59 " | |

Calorific capacity, 99.4 B. T. U.

Ratio of calorific capacity of CO. to total, 96 per cent.

This gas certainly does not fill the requirements laid down by Mr. Dowson, for it has barely 100 B. T. U. of calorific capacity per cubic foot. Yet in tests of gas engines carried out by me with gas of this value, perfect results have been secured both in prompt ignition and in uniform steady expansion curves, showing that success is a matter largely of properly regulated compression, which is a difficult matter to secure where small producers are used to give hydrogenised gas, for the hydrogen is so apt to vary in amount that the compression cannot be satisfactorily adjusted. Others have also expressed their dissatisfaction with gas so low in heat value as 100 B. T. U., and it is to be feared that to these objections much of the opposition to the employment of that huge waste of blast-furnace gas has been due in Great Britain. On the continent especially this hitherto nearly wasted product has been largely utilised, and as the first immediate result gas engines of very large powers are plentiful and the gas-engine industry has received an impetus that it has wanted in Great Britain. When the value of blast-furnace gas has been finally recognised, the British builders of large gas engines will be unable to supply the demand and for some time large gas engines will be imported. The Düsseldorf Exhibition shows the position of the continental gas-engine industry very clearly.

The efficiency of combustion is a function of the degree of compression prior to ignition of the charge. In early experiments with gas as poor as 80 to 100 B. T. U. per cubic foot it was found necessary at once to raise the compression from an absolute of 4 atmospheres to 7 or 8 atmospheres, a rate that would be more or less risky with hydrogen in too great a proportion. Experience has shown that the degree of compression should be inversely as the calorific power of the gas used.

While on the Continent tens of thousands of horse power are being installed from blast-furnace gas containing little or no hydrogen, what do we find in England, where gases of over 15 per cent. of hydrogen have been attempted at various electric stations? The gas power has been replaced by steam power. Leyton, Kings Lynn, Morecambe, Belfast,—what has been the fate of the hydrogenous gas-power installations at these places? Where have they failed to give satisfaction? It is found that non-hydrogenised gases are steadily extending their field of operation, and that the hydrogenised gases are associated with failure except perhaps in the smaller powers, may it not be fairly ascribed to the effects and causes pointed out in the foregoing?

It is none the less remarkable that just when the doom of the hydrogenised gases appears to be imminent, the gas engine in which a too facile ignition is impossible should make its successful début. Hydrogen as a constituent of power gas will lose all its disadvantages, unless it be that of loss due to heat latency. Every gas used in the Diesel engine will be used to the full extent of its possibilities at present in our knowledge, and in the Diesel engine there is present a motor with a certainty of action and a steadiness of impulse and movement that will go far towards putting gas engines on a par with the steam engine in certainty of action and quietness, while far ahead of the steam engine in thermodynamic efficiency.

In experimenting with the petrol engines I have constantly been hampered by the difficulty of compressing to a desirable degree and have found it necessary to keep this feature moderate, as well as to guard against projections from the plain surface of the internal parts of the cylinder, such parts becoming hot and causing ignition, often before full compression has been attained. Petrol has no difficulties for the Diesel engine. The progress of the gas engine and the means of producing gas is indeed somewhat on a par with that of the gun and the armour against which it is pitted. Each has in turn taken a step in advance of the other.

# THE ECONOMICAL SIGNIFICANCE OF A HIGH WAGE RATE.

### *By Percy Longmuir.*

**The ultimate expensiveness of low-priced labour has been argued often and from many points of view. Mr. W. E. Partridge, writing in this Magazine ten years ago (August, 1892), brought together a number of striking examples, chiefly from American practice, exemplifying the fact. Mr. Longmuir, studying wholly British conditions, makes a very clear analysis of the reasons. It is the more impressive because so deliberately unimpassioned. The cold logic of a mechanical demonstration may be more effective in industrial reform than any sympathetic appeal of the humanitarian. In our Editorial Comment this month we have more to say of the fallacy which leads to "sweating"—the fallacy that it is the time, instead of the product or output, of the worker that is bought by the employer.—The Editors.**

LEST the heading of this article be misunderstood, I would clearly state at its commencement that my text is not "the higher the wages the greater the economy," for it is very obvious that an increase of wage without a proportionate increase in either the quantity or the quality of the product will not tend to economy.

In all industrial operations subject to competitive stress, effort is concentrated to one issue—that is, towards an increase of quality together with a decrease in the unit cost of the article produced. To achieve this end, mechanical means are the first essential; but it is very well recognised that the successful developement of mechanical appliances depends on the amount of effort put forth by the human faculty controlling the mechanical share of the work. In the evolution of industry, advances made in mechanical appliances and processes must be coincident with similar advances on the part of the human working force. Should conditions be otherwise, and the personnel of the working forces not advance correspondingly with newer methods and newer tools, then naturally the benefits of the latter will be minimised to the extent indicated by the lack of developement in the former.

It is very permissible to regard what have just been termed the "human working forces" as energy-producing machines, and in so doing the work produced may represent a definite mechanical product. The nature of this product of the human machine will depend on two things—first his willingness, and second, his physical fitness. In this work-a-day world, dominated as it is by what, for want of a better term, must be defined as "human nature," there are numbers physically fit, but who, owing to mental obtuseness, narrowing environment, or laziness unadulterated, are mentally very unwilling to produce an amount of work equivalent to their physical condition. But there are also numbers mentally willing, yet physically very unfit to produce a normal amount of work or energy. Both these classes have a very considerable effect on the cost and character of the work they produce, and the elimination of either evil would mark a very distinct advance in industrial evolution. The former—that of mental unwillingness—is purely an educational question; the latter—that of physical fitness—is perhaps one of larger moment, and certainly a very pressing question in Britain today. We are confronted with a constantly growing army of physical non-efficients, and if the profession of engineering is to be the dominating one of the future, as has been already indicated in the pages of this Magazine, then this question of physical deterioration is primarily one of engineering importance, and one of special moment to those engineers in charge of large bodies of men. In previous articles* some of the root causes underlying this deterioration have been noted, and in the present one an effort has been made to trace the relationship between the rate of wages paid and its effect on the character or quality of the work produced—in other words, to examine broadly the matter of a high wage rate and whether or no such a rate is conducive to economical production. The term "high wage rate" is one which does not admit a ready definition; in the case of skilled labour it is usually regarded as anything higher than the rate prevailing in the district, but with unskilled labour it is extremely difficult to determine rates that may be fairly regarded as low or high. This difficulty is increased by the varying character of the work classed as unskilled, and in order not to err on the sympathetic side, nor yet on the other hand to take an unjust view, it seemed well to class as a high wage rate for unskilled workers a sum just sufficient to maintain the worker and his family in a state of bare physical efficiency. Such a sum will of necessity vary according to the size of the workers family, and in some degree with the locality; but no better average can be found than that adopted by Mr. B. S. Rowntree of York in his exhaustive work on "Poverty." In fixing a poverty line, that is, a sum at which the worker might be regarded as just beyond the range of actual poverty, Mr. Rowntree went very thoroughly into the matter of economical food and the amount necessary to maintain bare physical efficiency. Without giving details of this very untempting scale of diet, I may quote the figures necessary to my purpose. Assuming the family to consist of five persons, that is, the parents and three children (which by the way is a low average of the families of unskilled workers in Great Britain), then the weekly items are tabulated as follows:

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* The Engineering Magazine, January, March, and April, 1902.

| | | s. | d. |
|---|---|---|---|
| Food for two adults, 3s. each per week | | 6 | 0 |
| Food for three children, 2s. 3d | | 6 | 9 |
| Rent per week | | 4 | 0 |
| Clothes for two adults, 6d | | 1 | 0 |
| Clothes for three children, 5d | | 1 | 3 |
| All else, five persons, 2d | | | 10 |
| Fuel and kindred charges | | 1 | 10 |
| | £1 | 1 | 8 |

By no possible stretch of imagination can the foregoing table be called an extravagant one, and in view of its essential fairness it forms a very appropriate standard for our purpose. It must, however, be remembered that this figure covers only the bare maintenance of bodily efficiency. It allows nothing for sickness, nothing for luxuries, not even a postage stamp or an evening paper. Therefore families in receipt of an income less than 21s. 8d. per week are in a condition of absolute poverty, and the wage earner cannot possibly be in a state of physical efficiency. The only wage earners coming below this poverty line are the ones known as unskilled labourers, and in considering the effect of a wage rate it will be necessary to separate this class from the one generally known as skilled workers. Obviously in considering the economy of the question the two cases must be viewed from very different standpoints, and it will be better to devote the first section to that of unskilled workers.

Unskilled Workers.—General labourers, who form the greater portion of this class, are in one sense non-producers, and are often regarded as costly no matter what relationship their rate of pay and the character of the work they perform bear to each other. In this paper only adult labourers are considered, and for convenience these may be divided into classes representing districts of Britain in which the rates vary as follows:

1. 16s. to 18s. per week.
2. 18s. to 20s. " "
3. 20s. to 22s. " "
4. 22s. to 24s. " "

The week in all cases consists of fifty-four hours. Classes 3 and 4 may be regarded as high rates for the character of the work done, whilst classes 1 and 2 are distinctly low rates.

Areas in which the rates 1 and 2 are operative cover a considerable portion of Great Britain, and a preliminary glance at the recipients of these rates gives an impression that they are worth no more. As a rule they are saturated with specimens any recruiting sergeant or railroad ganger would regard as hopeless. Truly, the average appears to be one poorly equipped for the work termed unskilled, in which strength of body is all important.

Areas in which the rates 3 and 4 are operative contain the pick ot the physique of the labouring classes. Among the ranks of these workers the hardiest and most wiry are to be found, and consequently the averages of these classes appear on very casual glance to be worth 24s. in far greater measure than is the average of class 1 and 2 worth 16s. per week.

This method of classing into districts governed by a uniform rate may possibly be questioned, but close observation over very wide areas points conclusively to the fact that the *élite* of the unskilled workers gravitate to those districts in which wages are higher. In spite of overcrowding and the restricting influences of town life, there is a constant influx of country labour into all our large towns; they respond to the magnet of a high wage rate quite irrespective of a possibly enhanced cost of living or other drawback. Naturally, then, the various grades of labour find themselves distributed in areas very representative of their physical fitness. Thus we have a seeming paradox, in that the country districts, whilst supplying the strongest and healthiest workers to the towns, are in themselves tenanted by workers of a lower physique. Once the youth of the country town or village feels able to command the, to him, high wages of a thickly populated centre, he quits his weekly income of 10 or 12s. and migrates to a possibility of 18s. or 24s. Should his condition fit him for the work, he will in all probability stay for life; but if otherwise, the inexorable process of sifting will drift him downward until he finds a level fitted for his capacity. A very striking example of this migration of country physique is to be found in the immediate district in which these words are penned. The extremely heavy and arduous labour classed as unskilled or partly skilled in the large steel works of the district, and that of the railroads, too, is for the most part performed by natives of the neighbouring agricultural county of Lincoln. This is the case with all large towns; they draw their supply of strength from the country districts, the natives of which, reared in the free air of pasture land or moorland, can readily compete with the average of stunted town growth when a question of bodily efficiency only is considered.

Examination of the prevalent rates for unskilled labour indicates that by far the greater part of the labourers in Great Britain are well below Rowntree's poverty line—that is to say, unless the wives work the total family income is below 21s. 8d. per week, and in many cases very much below. If the income is below the poverty line, no possible fancy of economical housekeeping will maintain that family in a condition of physical efficiency. With an unskilled labourer the first essential to constant employment is that of bodily efficiency, and from a financial point of view it is folly to employ a man in such a capacity who is otherwise than physically fit. For it is obvious that a man so handicapped cannot possibly do full justice to the work in hand, no matter how desirous he may be of doing so. His income will not allow him to supply his body with the necessary energy or fuel to yield the requisite amount of work. Just as no amount of forcing will make a machine yield more than the energy it represents, so no amount of hustling will get out of a man more energy than that represented by the scale of his diet. Successful hustling may obtain more show of energy, but it can not make the human machine yield more actual energy than that represented by its fuel or food. It may be argued that the quality of an unskilled labourer's food is hardly a question of moment to the busy engineer or works manager, but from our present point of view, that of an energy producer, it is all-important; and it is to this food, just as to the fuel that feeds his boilers, that the engineer must look for the energy which is to carry through his work efficiently and cheaply.

A practical illustration occurs at this moment. In gathering matter for the purpose of this paper, I studied for some time a very representative class of labourers in an area in which the standard rate was 16s. per week. Many of these men carried dinners to work, and the appearance of these parcels when opened at dinner time gave no little insight into the reason for lack of "go," and the almost complete absence of staying power, by which these men were characterised. As is usual with this class, the quantity and quality of the food fell as the week progressed, and towards the end the dinners usually consisted of bread and cheese or of bread smeared with lard or margarine, and occasionally dry bread only washed down with tea. One set of four men were in the habit of clubbing together and purchasing a luxury when their parcels happened to contain, as was not infrequent, bread only. They would subscribe a halfpenny each for the purpose of this luxury, which often as not consisted of a twopenny bottle of doubtful "pickles." Should this seem exaggerated to any reader, I would ask him to divide carefully a weekly income—when full weeks are worked—of sixteen shillings, and make it cover all charges for a family—rent, food, fuel, clothing and contingencies such as sickness, absence or scarcity of employment, etc. Such an arithmetical exercise will doubtless demonstrate the fact that not all Britons fare on the time-honoured roast beef and plum duff.

That men on the diet just indicated are unfit for heavy and active work is readily apparent, and as a natural result in all districts having a low wage rate the works are found to be considerably overstaffed with unskilled labourers. It is no uncommon occurrence to find two men handling with difficulty a load that in a higher rated area, with consequently better calibre of men, would be readily tackled by one. That is to say, twenty-four shillings will do in a better manner work that in the low-rated and "cheap-labour" districts is costing thirty-two shillings. It is right here that the false economy of a wage rate upon which it is impossible to maintain any semblance of physical efficiency shows most distinctly.

The recipients of such a rate are necessarily stunted bodily; endurance and continued application are impossible; and with these evils are always associated mental torpidity or stagnation. Thus it is always found that to the incapacity to enter heartily and continuously into manual work is added mental blindness which very effectually prevents the adoption of system and "short cuts" in the accomplishment of that work. Briefly, then, in the low-wage areas the class of unskilled labour may be summarised as lacking in physical efficiency, possessing little or no endurance and no staying power, having no application. In short, they are apathetic, bodily and mentally, and it is evident that no matter how low the rate of pay or how intense the method of "drive," such a class of labour can never be satisfactory.

It has been already stated that the higher-rated districts contain the pick of the physique of the labouring classes, and this is more noticeable as the rate approaches four and twenty shillings per week. The men are better physically, and with this increase of physical efficiency is to be found a corresponding increase in mental capacity which results in the intuitive adoption of shorter and more direct methods in the accomplishment of work.

The Economy of the Question.—In this paper the only trace of sympathy admitted is that now familiarly known as "sympathetic works management," in which form of management sympathy is recognised as a paying factor. Therefore in looking at the matter of low-rated unskilled labour, the foremost question is, will the adoption of higher rates be attended with a corresponding increase in the cost of production, or will the cost remain stationary? That is to say, will each shilling rise give an extra shilling's worth of work, or, assuming the wages to be increased from sixteen to twenty-four shillings, will the man so raised be enabled to give half as much work again, or will his product remain the same? In the cases familiar to the writer these questions, when put to a practical test, have been answered very strongly in the affirmative. Experience undoubtedly proves that an increase of wages results, with judicious management, in a corresponding increase of output. If this increase in output is proportional only to the amount of increase in wage, that is, if only one shilling's worth of extra work follows a shilling extra on the pay, then such an increase is economically justifiable. For increased output per unit results in a lessening of staff, which is followed by a lessening of management worries, clerical expenses, and a considerable diminution in risks such as come under the Compensation Act. But experience shows that the increase in wage results in a greater increase in the amount of extra work produced. Speaking generally, an unskilled labourer rated at twenty-four shillings will produce twice the amount of work to be obtained from one rated at sixteen shillings. Not only does he do twice the amount of work, but he also does it in a better and more workmanlike fashion. Thus an increase of eight shillings effects a direct saving of eight shillings, in addition to the indirect economy effected by a better product, more careful use of tools, and lessened management expenses. The economical significance of the wages rate is further shown in the following rough outline of the leading features familiar to low- and high-rated areas.

| | |
|---|---|
| Low-rated areas. | 1. Slow, unthinking, require direction at almost every step. |
| | 2. Clumsy; tools do not receive justice, either in method of handling or making them yield the most. |
| | 3. Low perception, no foresight, which tells heavily when working in conjunction with skilled labour. |
| | 4. High waste due to the non-recognition of the value of time, material, or tools. |
| High-rated areas. | 1. Smarter, more methodical, require less personal direction. |
| | 2. Careful and more intelligent use of tools. |
| | 3. Higher perception, intuitiveness, requirements anticipated and skilled workers' time economised. |
| | 4. Less waste, due to better use of time, material, and tools. |
| | 5. Less strain on the management. |

The higher rates permit an increase of physical efficiency which in turn results in an advance of mental capacity. The developement of perception has an important effect on the work to be done, even though it be termed unskilled, as may be seen to good advantage when employed in association with skilled labour. In this case the efficiency of the labourer consists in anticipating the craftsman's requirements and in having everything ready to his hand, so that the work may progress smoothly and without interruption. In cases where perceptions are low, much of the craftsman's time is wasted in drilling and waiting for the labourer. The practical application of this increase in mental capacity is found in the better quality of the work done; instructions are more efficiently followed, tools intelligently used and cared for, and wits are set to work in conjunction with the body—that is to say, the apathy and dulness which often approaches senility, found with the semi-starvation of the low-rated areas, are replaced in the high-rated ones by systematic, methodical, and intelligent work.

Of the departments connected with an engineering establishment that of the foundry usually employs the largest proportion of unskilled labour. The labour is employed chiefly in association with the skilled labour in handling the heavy material, moulding boxes, and plates, and in preparing sand, etc. Owing to the absolute dependence of the skilled labour on the unskilled worker, and also the variety of work classed as unskilled, the foundry offers a good field in which to test practically the economy of a high rate. A comparison of two foundries in which the rates average respectively twenty-four and sixteen shillings per week, and in which conditions of management, character of product, etc., are very similar, conclusively testifies to the economy of the higher rate. The range of selection offered by this rate is such as to ensure the employment of picked men. The chief item of comparison—that of unskilled-labour cost per ton of good castings produced—is distinctly in favour of the higher rate. Not only is this the case, but subsidiary items, such as the repair and renewal of moulding boxes, which of necessity have to be handled by labourers, amount with the increased care and thought derived from the higher quality of the labour to considerably less per annum than is the case with the so called cheap labour. The thought put into the work is very effectual, as evidenced by economy of material such as facing sands, facings, core irons, lifters, sprigs, and the like. The smaller number and greater reliability of the men gives rise to a further factor of economy, in the relief afforded to the skilled worker and to the management.

# A REVIEW OF WIRELESS-TELEGRAPH ENGINEERING PRACTICE.

*By A. Frederick Collins.*

Wireless telegraphy has advanced with wonderful swiftness from the position of a scientific curiosity to that of a branch of applied electricity. It is apparently destined not to supplant pre-existing agencies, except to a very limited extent; but rather to perform new functions for which preceding means of electric communication were not adapted.

Mr. Collins makes the first complete survey of the field, showing what are the fundamental elements common to all systems, and what the special features of method or apparatus peculiar to each.—The Editors.

RECENT developments in wireless telegraphy, theoretical and practical, have placed this latest and greatest triumph of modern science in the domain of electrical-engineering practice, for it is now possible to design apparatus for the transmission and reception of electric waves to a distance of 100 miles with as much certainty of result and accuracy of action as it is a 1,000-kilowatt alternator.

At the present time there are several companies engaged in the manufacture, sale, and installation of instruments in the United States, in England, and on the Continent, and among the better known systems are those of Signor Guglielmo Marconi of England, Prof. Ferdinand Braun and Dr. Adolph Slaby of Germany, Mons. Emile Guarini Foresio of Belgium, Mons. E. Ducretet of France, Señor Julio Cervera Baviera of Spain, and Prof. Reginald Fessenden and Dr. Lee de Forest of the United States.

Whilst all these systems of wireless telegraphy are based on the same fundamental principles, there is a vast difference in their electrical and mechanical construction, as will be observed by comparison; this difference is due in some cases to the applicability of divers devices which perform virtually the same functions, but in the greater number of instances, this variation is the result of widely divergent opinions resulting from theoretical considerations; and again, individual inventive ability figures largely in the apparatus personified by the names above.

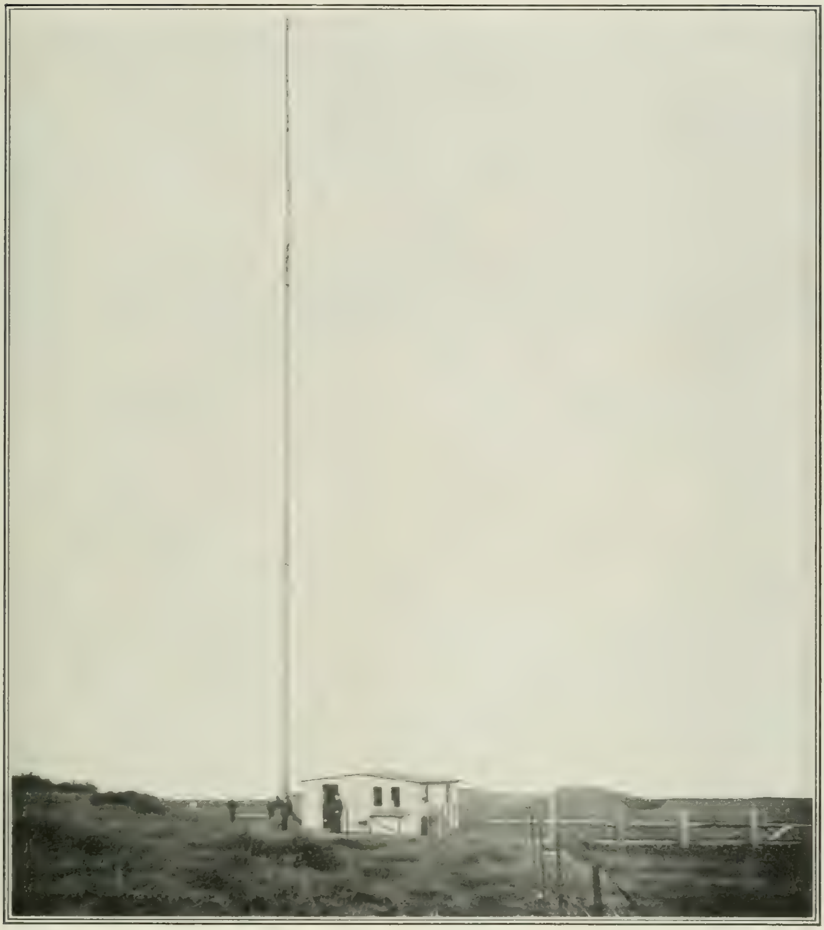
The greatest interest in wireless telegraphy at the present time, lies in the question of similarity of the component parts of the apparatus as a whole, for mighty legal battles will be waged in the near future with all the dynamic virulence which characterized the wars of the telephone companies, since priority of discovery and invention of the various workers and the commercial monopoly the patent rights grant to the different companies will be sustained by each, if possible.

Taking into consideration these three factors, *i. e.,* the scientific, the commercial and the legal phases of the art, the following text will be divided into three portions, the first of which will treat briefly the historical, the second dealing with the theoretical, and the last with the practical aspect of wireless telegraphy.

Historical:—The history of signalling through space without wires may be said to date back to the time of Lindsay—when he transmitted and received messages across the river Dee in Scotland by what is now known as the conductivity method; from that year until 1896 a number of schemes were formulated and some of them were put into experimental execution, including the induction method of Preece and the electrostatic methods of Edison and Dolbear; but until Marconi introduced the electromagnetic wave system, wireless telegraphy belonged to the practicable as distinguished from the practical period of its evolution; hence all systems other than those employing Hertzian waves will be excluded from this treatise.

A transmitter for the production and propagation of electric waves includes a source of current, means for interrupting a direct current (or an alternating current may be used), means for changing the interrupted or alternating current into low-frequency, high-potential currents, and means for transforming these into high-frequency, high-potential oscillations—such as are produced by the disruptive discharge of a Leyden jar through a circuit having a small resistance—and means for converting the oscillations into electric waves and emitting them; the receiver must provide means for intercepting the electric waves, and re-transforming them into electric oscillations, means for detecting minute differences of potential created by the enfeebled oscillations thus set up, and means for manifesting, either visually or audibly, these oscillatory hieroglyphics and translating them into readable Morse; besides other appliances having various special functions.

Without delving into the records of direct, alternating, and induced currents, the history of which is well-known, a mere retrospective glance at oscillatory currents—which play so important a *rôle* in wireless telegraphy—will suffice to illustrate the real beginning of the knowledge upon which the art is founded. Felix Savary, in 1827, postulated with marvelous accuracy the now accepted theory of the oscillatory nature of a disruptive discharge, showing that the charges of the inner and outer coatings of a condenser were not restored to



EXTERIOR OF WIRELESS-TELEGRAPH STATION AT CUXHAVEN, GERMANY.
BRAUN SYSTEM.

zero potential by the mere single passage of current electricity in one direction, but that the equalization was due to several reflex actions—like the vibrations of a steel spring—before the electrical equilibrium was obtained. Joseph Henry in 1842 obtained experimental proof of this phenomenon by observing the changes of polarity in fine steel needles when magnetized by a frictional (plate-glass) electric machine at a distance. In 1847, Von Helmholtz published in his "Conservation of Energy" his deductions relating to oscillatory currents, proving mathematically that the discharge of a Leyden jar is a "backward and forward motion until the entire *vis viva* is destroyed by the sum of the resistances." In 1852 these deductions were verified by Sir William Thomson, now Lord Kelvin, who worked out the theory on the experimental evidence of Faraday, who had obtained oxygen and hydrogen mixed at either pole. Lord Kelvin suggested a method by which the spark of a discharge could be segregated, by means of a Wheatstone revolving mirror, and in 1859 Fedderson adopted this means and succeeded in detecting a series of minute sparks and placing the work of those before him on a sound physical plane.

Through another of Faraday's classical experiments, James Clerk-Maxwell was led, in 1865, to evolve his electromagnetic theory of light which, simply stated, resolves all forms of transverse vibrations of the ether, or polarizations, into waves composed of magnetic whirls and electric displacements alternately; he determined mathematically that these polarizations were due to rapidly moving charges of electricity shearing the ether—as when an oscillatory current of a discharged Leyden jar traverses its circuit; likewise it was ascertained that the periodicity of oscillation depended on the size of the body in which the current surged; on a body of atomic size it would oscillate trillions of times per second, emitting visible waves, but on a sphere of say, a meter in diameter, electric waves nearly 150 centimeters in length will be emitted and though these latter waves are invisible to the eye, they are as truly electromagnetic in character as light waves. This was the mathematical theory of Maxwell, but like the deductions of Von Helmholtz it required verification by actual experiment. This was forthcoming in 1888, when Heinrich Hertz succeeded in producing electromagnetic waves (to which he subsequently gave the shorter name of electric waves) standing in free space and gliding over wires; he showed that they could be reflected, refracted, polarized, diffused, and generally followed optical laws just as though they were light waves. This achievement was the first real advance toward the art of wireless telegraphy.

As a detector of electric waves at a distance from whence they were emitted, Hertz employed a circlet of wire having an air gap in it of microscopic size; this he termed a "resonator." The distance to which waves could be detected with it was very limited, but it served Hertz's purpose admirably. The next step toward electric-wave transmission without wires was made in 1890, when Edouard Branly, in a course of experiments showing the "variations of conductivity under electrical influence," found that metal filings placed in a tube having terminal conductor plugs was marvelously sensitive to feeble oscillations set up by impinging electric waves, and to this electric eye he gave the name of *"radio-conductor"*; Lodge renamed it *"coherer."*

The first apparatus having all the essentials of a modern wireless-telegraph receiver was designed by Prof. Popoff in 1895, but was employed by him as a meterological detector of distant storms, registering their presence by means of electric waves, emitted by the lightning, impinging on a vertical wire connected with the ground through a coherer. The first practical transmitter for wireless telegraphy was constructed by Marconi in 1896, when he added a vertical wire to one arm of an oscillator and grounded the opposite arm, making it the physical counterpart of his resonator, which was designed on the same general lines as the receiver of Popoff. This brings the history of the art to the time of its commercial solution. From this period to the present date, new workers, with one exception, have been responsible for the systems herein described. These systems have been designed not only to cover extreme distances, but also to render possible the selective interchange of messages, or syntonic wireless telegraphy.

H. M. S. ABOUKIR, EQUIPPED WITH MARCONI APPARATUS.

Theoretical:—The theory of the propagation of electric waves over long distances has been the subject of considerable recent discussion in the United States, but fortunately this phase of Maxwell's deductions does not enter into the practice of wireless-telegraph engineering to any great extent; a brief outline of the two principal conclusions which have been reached, and the solution of the acting referee, will serve, however, to show the trend of opinion upon this subject.

Any theory advanced must conform with Maxwell's conceptions and the experiments of Hertz, but as the fundamental equations by which Maxwell evolved his theory are as broad as they are beautiful, its interpretations by various technicians are widely divergent, and the final solution is rendered all the more difficult when Hertz's work is consulted; for he not only observed electric waves in free space, but waves which traverse the surface of wires as well.

The first of these theories is based on Hertz's experiments embodied in his paper "On the Propagation of Electric Waves by Means of Wires," in which he shows how transverse electrical displacements, or sliding waves traveling over a conducting wire, may be produced; or, to quote Hertz's own words, "the electric force which determines the current is not propagated in the wire itself, but under all circumstances penetrates from without into the wire, and spreads into the metal with comparative slowness and according to laws similar to those which govern changes of temperature in a conducting body." This is due to the inductance, and when the frequency of the current is of the order of millions per second, by virtue of the opposition inductance offers to such high frequencies, the current must flow on the surface of the wire."

On the assumption that the earth is a perfect conductor, Prof. Reginald Fessenden and others elucidate the theory of wireless transmission based on the postulate of semi-free and half waves. These are caused by the electric waves which stream from the antennae to the earth and, striking it, are detached and the half waves skim over its surface as in the case of Hertz's experiment just cited. To complete this theory it is further assumed that the opposite arm of the oscillator —which is grounded—does not emit waves, and that the opposite half of the wave is mythical, like the reflection of an object in a mirror.

The second theory is that advanced by the author and others, and accounts for the rectilinear propagation of electric waves in accordance with Hertz's physical demonstration of Maxwell's elecromagnetic theory of light. In his paper "On Electric Radiation," Hertz showed how free electric waves or transverse vibrations of the ether—identical with light waves, but longer—may be made to follow all the known laws of light.

This theory is based on the assumption that electric oscillations, surging with high frequency through the oscillator system formed by the antennae and the earthed terminal, emit free electric waves which are propagated through space just as are light waves by the vibratory charge of electricity on gaseous atoms. Where the curvature of the earth intervenes, it is assumed the waves are reflected like the rays of the sun producing twilight and dawn.

As a balm to the contending parties in these opposition theories, Dr. Arthur E. Kennelly asserts that both are right, by showing how the emitted wave not only traverses space in the form of transverse vibrations, but that portion of it which comes in contact with the earth slides over it.

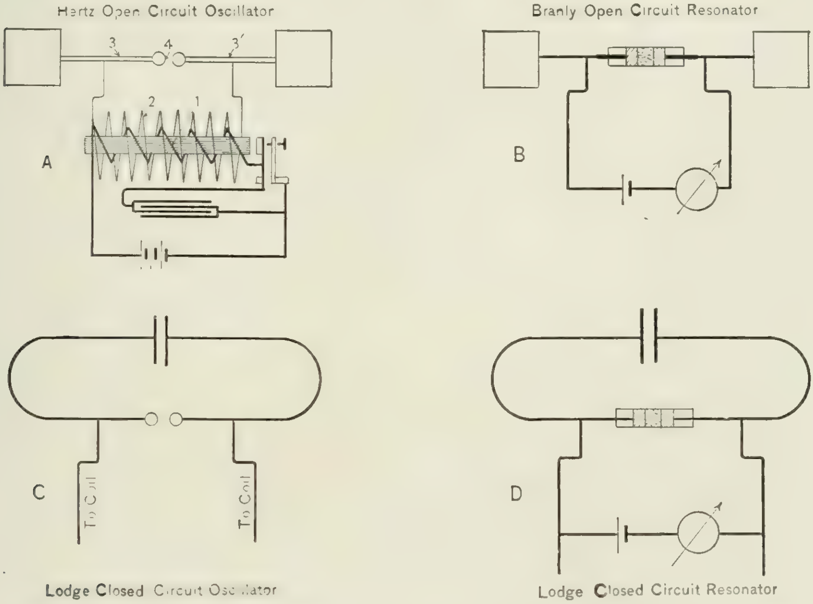

Hertz Open Circuit Oscillator
3
4
3′
2
1
A
Branly Open Circuit Resonator
B
C
To Coil
To Coil
D
Lodge Closed Circuit Oscillator
Lodge Closed Circuit Resonator

FIG. I. DIAGRAM ILLUSTRATIVE OF APPARATUS FOR PRODUCING AND RECEIVING ELECTRIC WAVES.

The theory involving the method of producing and receiving electric waves is much more easily defined. The apparatus consists essentially of three electric circuits, shown in Fig. 1, A B C D; 1 A represents the inductor or primary winding of a Ruhmkorff coil, and 2 the secondary winding, in which low-frequency high-potential currents are set up; 3 3′ is the oscillator wherein the high-potential charge is transformed into electric oscillations of enormous frequency by means of the disruptive discharge taking place in the spark gap, 4. These three circuits may be regarded as entirely distinct and separate from the other, for, though the oscillator is connected directly to the terminals of the secondary, the latter is employed merely to charge the oscillator 3 3′ to a potential high enough to break down the air gap, 4; the great inductance of the secondary causes it to choke the oscillations, rendering the secondary impervious to it.

Again, the oscillator system may be of either the open-circuit type, Figure 1 A, or closed-circuit type, Figure 1 C. Lodge has shown that whereas the open-circuit oscillator is a most excellent emitter of waves, though these are damped out very rapidly, the function of the closed-circuit resonator is diametrically opposite, in that the oscillations are exceedingly persistent but are emitted very feebly. Therefore the open-circuit oscillator is pre-eminently the best adapted for long-distant transmission, whereas the closed circuit is at once commendable for resonance effects in syntonic systems. Likewise the resonator of the receiver may be of either the open- or closed-circuit type, as shown in Figure 1, B and D.

The frequency of the oscillations in either case depends on the coefficients of the circuit; these are its inductance, capacity, and resistance. Inductance finds its analogue in mechanical inertia, for a current requires time for its acceleration in a conductor and time for its retardation. The capacity of an oscillator system is determined by the quantity of electricity required to raise its potential to the critical value where the charge will disrupt the air gap at 4, and depends not only on the dimensions of the oscillator but the potential which is impressed upon it. The ohmic resistance of an oscillator is in reality exceedingly small, that is to say that it is *less* than the square root of the inductance divided by the capacity, and may be likened to the mechanical action of friction; therefore the current describes a curve that is periodic and alternate with maxima gradually decreasing in geometric progression; but if the resistance is imaginary—that is, if it is *greater* than the square root of the inductance divided by the capacity—there can be no oscillations and the current will be continuous and unidirectional.

In simple wireless telegraph systems these coefficients are of little importance; all that is needed is a good emitter, as the length of the wave may vary within wide limits without ill effects. But in syntonized systems they are at once mighty factors, for by adjusting their values the oscillator and resonator may be attuned or syntonized to each other as in acoustic resonance, the emitted waves of the former setting up counter-oscillations in the latter of identically the same frequency, while if waves are emitted by an oscillator having a periodicity different from that of the resonator there will be no response, since the effect of increasing the inductance and capacity of the circuits is to slow down the frequency of the currents, and in turn longer waves are emitted. Again, the frequency of the oscillations may be stepped-up or stepped-down by transformers, following exactly the same laws as alternating currents in general.

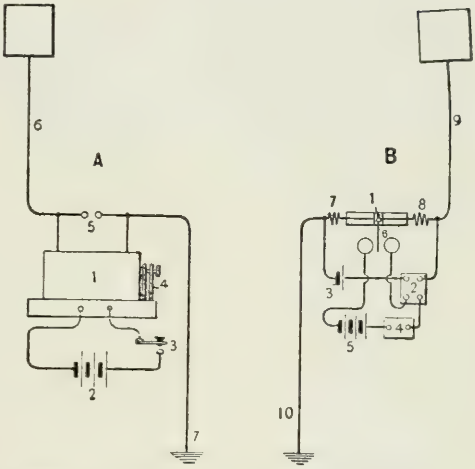


FIG. 2. DIAGRAM OF ORIGINAL MARCONI TRANSMITTER AND RECEIVER.

Practical:—Based on the preceding theoretical deductions wireless telegraph apparatus may be divided into two general classes: (a) those constructed on non-syntonic lines, designed simply to cover long distances; and (b), those contrived to fulfill the laws of electrical resonance, or syntonic systems for individual selective telegraphy.

The first practical electric-wave system was, as a matter of evolution, of the non-syntonic class. In Figure 2, a diagram of the original Marconi transmitter and receiver is shown. By comparing it with the Hertz apparatus, Figure 1 A, it will be seen that the only difference lies in the extension of one of the oscillator arms forming the antenna and grounding the opposite arm. The Marconi receiver is similar to the one invented by Popoff, and is the counterpart of the transmitter in that the resonator consists of a vertical wire as well as an earthed terminal and connected in series with a coherer; the oscillator and resonator are therefore, of the open-circuit type.

Referring to Figure 2, A; 1 represents an induction coil, 2 a source of current, 3 a key for arbitrarily making and breaking the current, 4 an automatic interrupter, 5 the spark gap of the oscillator, 6 the antennae, and 7 the earthed connection: The component parts of the receiver are depicted at B; 1 shows the coherer, 2 a polarized relay operated by the single cell 3 in series with 1, 2; an auxiliary circuit includes the Morse register 4, the writing contacts of the relay 2, the battery 5, and the decohering tapper 6; two small inductance coils 7, 8, are interposed between the coherer and the relay to intercept the miniature trains of electric waves set up by the minute sparks taking place between the platinum points of the working contacts upon breaking the auxiliary circuit; the resonator is formed by the antenna 9, and the earthed terminal 10. By this apparatus Marconi sent signals in London in 1896 a distance of 300 feet, and by constantly improving the sensitiveness of the receiving devices, by increasing the height and number of the antennae, and employing transmitters of greater power, he succeeded in transmitting readable messages a distance of nearly 2,000 miles in 1902.

The equipment Marconi employed in the days of his earliest successes, when he telegraphed across the English Channel, is illustrated in Figure 3. The transmitter is shown to the extreme right and the receiver to the left; the coherer and all other parts of the apparatus sensitive to electric waves are placed in metal boxes, to exclude extraneous waves and prevent injury to the delicate adjustments when the powerful oscillations of the transmitter are taking place. The boxes are connected with the ground and all waves not received by the antennae are conducted to the earth and there dissipated.

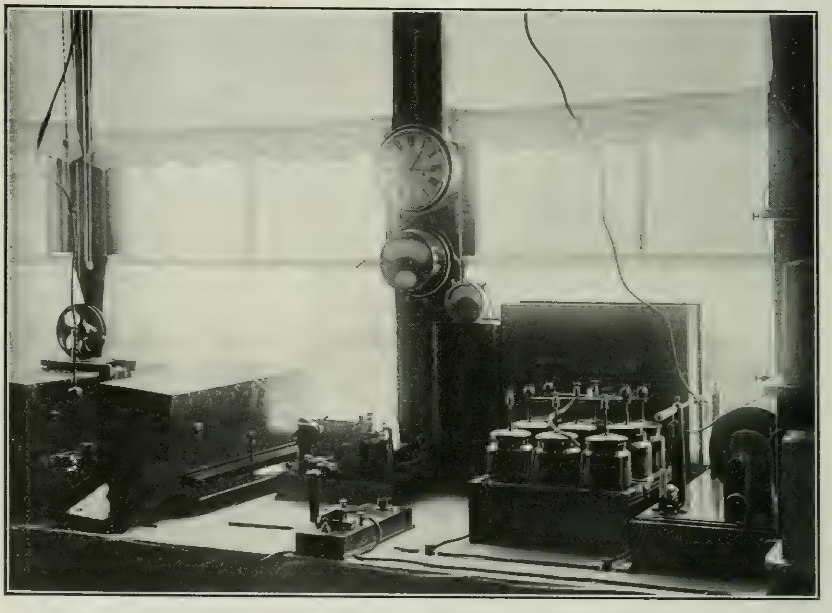


FIG. 3. INSTRUMENT ROOM, NORTH FORELAND STATION, MARCONI SYSTEM.
The station from which the earliest successful signalling across the English Channel was done.

But Marconi has been assiduous, not only in developing long-distance wireless transmission, but also in evolving a system which has

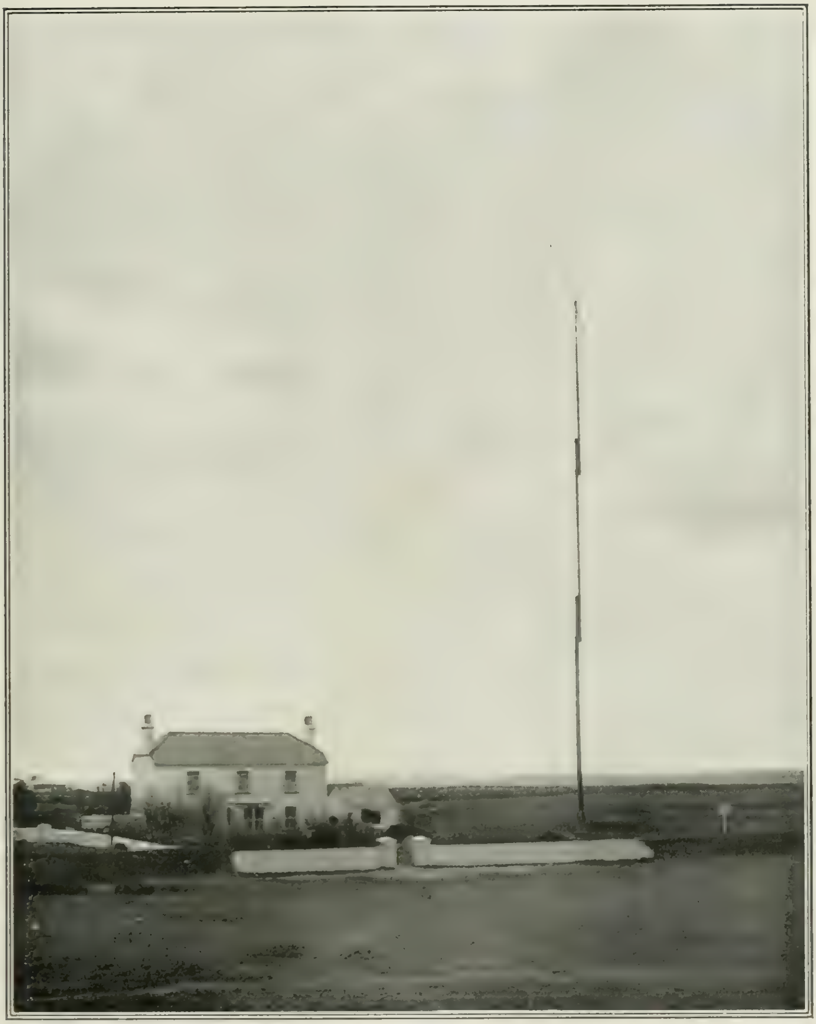


FIG. 4. MARCONI SHIP SIGNALLING STATION AT ROSSLARE, ON THE SOUTHEAST COAST OF IRELAND.

Showing mast and antennae leading to instrument room.

for its object individual selective signalling; in this new appartus the inventor has compounded the open- and closed-circuit oscillators and resonators, and thereby obtained the maximum penetrative efficiency of the emitted waves, and retained at the same time the maximum persistency. This syntonic system is shown diagramatically in Figure 5; I, I′ represent two copper cylinders employed instead of the usual antennae in the transmitter and receiver. These are connected to earth

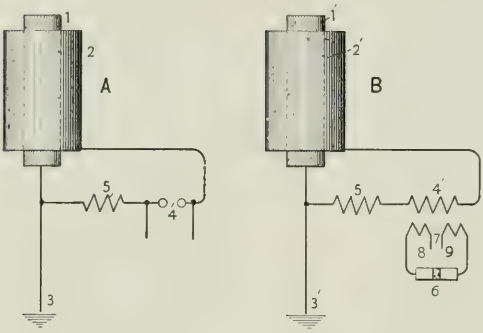


FIG. 5. DIAGRAM OF MARCONI SELECTIVE WIRELESS-TELEGRAPH SYSTEM.

at 3, 3′. Surrounding these cylinders are two metal cylinders of larger diameter, mounted in such a manner that an air space intervenes between them. In the transmitter (A) the outer cylinder is connected to one side of the spark gap 4, the opposite side terminating in the inner cylinder; 5 is a variable inductance; in the receiver (B) the two cylinders are connected through the primary by a small transformer coil 4′ and inductance coil 5′; the coherer 6 receives its impulses through the secondary of the transformer 7, the object of this arrangement being to allow the static differences of potential of the earth and outer cylinder to be equalized and not interfere with the coherer. The action of the instruments resembles that of two Leyden jars with closed circuits; when the disruptive discharge takes place in the air gap 4, the oscillations surge to and fro many times in the compound circuits before they die away; the waves emitted, though retaining somewhat the strength of those propagated by the open-circuit oscillator, form trains of waves, and these, impinging on the resonator circuit, set up oscillations which, though feeble at first, grow stronger through resonance until the potential difference impressed upon the terminal plugs of the coherer is raised to a value where it breaks down the minute insulating film of air separating the filings, and cohesion takes place. The local circuit containing the relay is attached to the termi-

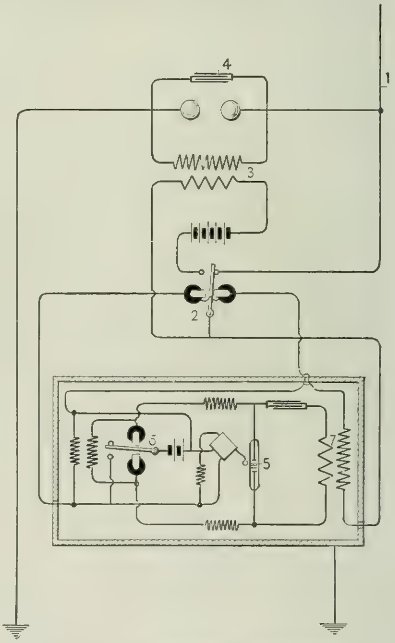


FIG. 6. GUARINI REPEATER.

1, antenna; 2, relay or aerial switch; 3, induction coil; 4, condenser, parallel to spark gap; 5, coherer; 6, relay; 7, transformer coil.

nals of the transformer coil 8, 9. Theoretically the values of inductance may be varied by the adjustable coils, 5, 5′, and the capacity changed by increasing or diminishing the dimensions and therefore the capacity of the cylinders. Another advance toward syntonization is due to Marconi, who has devised a new magnetic electric-wave detector—that is to say, the coherer is supplanted by a detector based on a new principle. This detector is made by winding a layer of fine insulated wire on a core of soft-iron wire; the terminals of this coil are connected with the antenna and earth respectively; over this is wound a second layer of the same sized wire, and these terminals are connected in series with a cell and telephone receiver. A magnet, operated by clockwork, revolves before the poles of the core and produces in it hysteresis by constantly increasing and decreasing magnetism, and by means of this cyclic change every oscillation set up in the primary coil by the impinging electric waves is marvelously accentuated. This detector is not only self-restoring, but its value in syntonic wireless telegraphy lies in the fact that its resistance is practically constant, whilst the coherer is always variable.

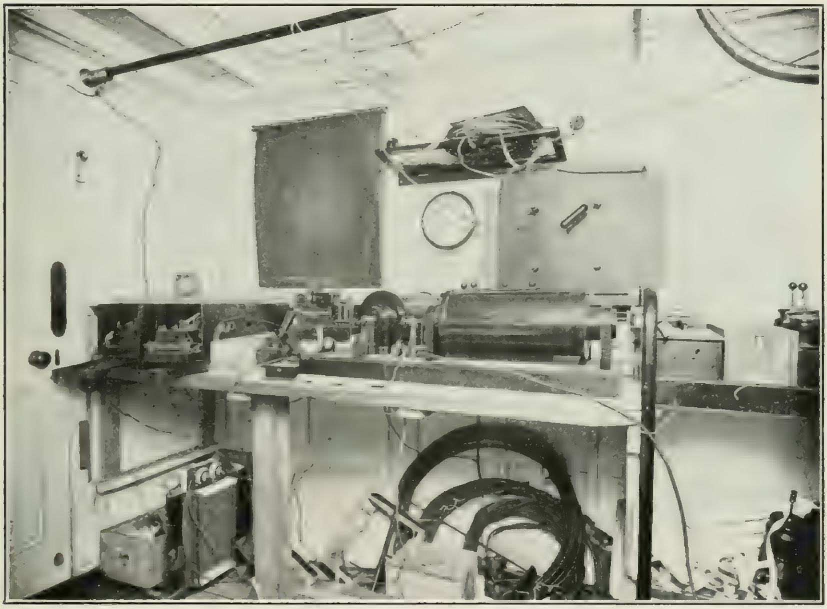


FIG. 7. MARCONI SELECTIVE WIRELESS-TELEGRAPH SYSTEM. STANDARD STATION SET ON S. S. PHILADELPHIA.

A series of clever experiments were made in 1901 by M. Emile Guarini Foresio and his colleague, Artillery Lieutenant Poncelot of

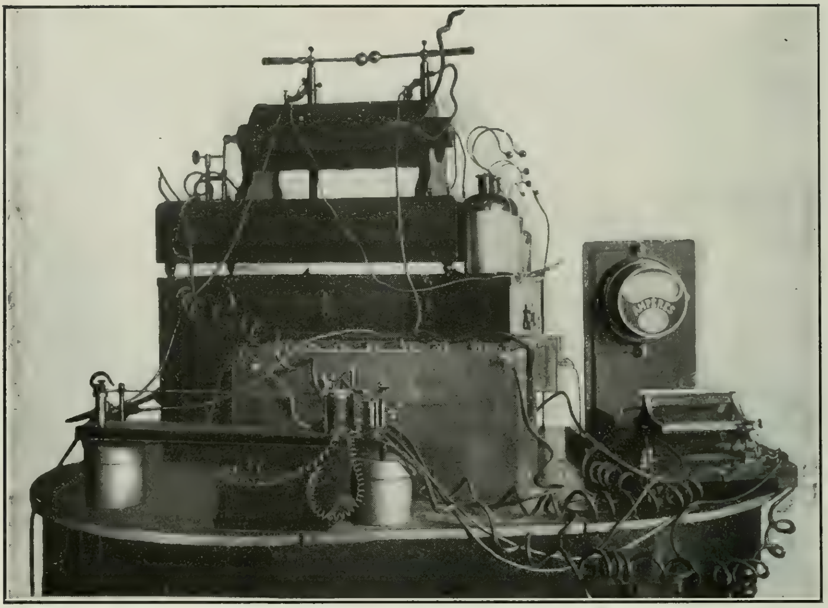


FIG. 8. GUARINI AUTOMATIC REPEATER.

Brussels, Belgium, in repeating automatically wireless-telegraph messages. At Antwerp and at Brussels, 25 miles apart, two standard station installations were made, whilst at Mechlin, a village situated midway between the two cities, Guarini's automatic repeater was employed to relay the messages. In wireless telegraphy the antenna is cut off from the receiver when the transmitter is in operation, and when messages are received this is reversed. It is evident that in a repeater this must be done automatically; the combination apparatus is shown diagramatically in Figure 6. Figure 8 shows photographically the method employed by Guarini for receiving the enfeebled waves and for all the subsequent translations from the coherer until the powerful re-energized waves are an instant later emitted from the same antenna.

A single antenna, 1, is connected to a relay, 2, of special construction, termed an aerial switch, and having double contact points; when the armature of this relay is drawn to the right, the receiver is placed in electrical connection with the antenna, and when thrown to the left the induction coil, 3, is set in action; 4 represents a condenser in parallel with the spark gap. A regenerable Blondel coherer, 5, is in series with an exceedingly sensitive relay, 6, and these, with the necessary inductance coils, are included in a metal box as previously described. The primary of a small transformer, 7, is connected to the antenna and led to earth through the metal box; when the oscillations surge through the primary they are impressed upon the secondary of the coil, and this being in series with the coherer produces a potential difference in the latter which in turn causes the filings to cohere. The value of repeating wireless messages cannot be over-estimated, and it is only a question of time when the great trans-Atlantic service will be equipped with repeaters, enabling continuous communication to be kept up between England and the United States.

The Popoff-Ducretet apparatus is based upon a memoir presented at the Paris Congress of Electricity by Prof. M. A. Popoff and the observations of M. E. Ducretet. The transmitter is constructed on orthodox lines and is the result of Ducretet's mechanical ability as an instrument maker. It consists of a regulation induction coil, an electromagnetic interrupter and oscillator of the Righi type, with the spark balls immersed in vaseline oil. The antenna is connected direct to one side of the spark gap and the earth to the opposite side.

The receiver of Popoff differs from those described in that it employs a self-righting coherer; this type of coherer generally contains carbon granules instead of silver and nickel filings, and its normal resistivity is restored without tapping or other device to effect decohesion. In receiving messages the antenna is connected to one of the conductor plugs of the coherer and the earth to the opposite one. The local circuit includes a single cell and a pair of head telephones, and the messages are read by the operator through the vibrations of the diaphragms of the telephone receivers, which respond to every change of the coherer. This type is much more sensitive than a metal-filings coherer, and as the energy required to operate a telephone receiver is hundreds of times less than for the most sensitive relay, the Popoff instrument is extremely valuable for receiving messages at greater distances from the transmitter than is possible with the more complicated apparatus utilized in the standard station sets. The Ducretet transmitter is similar to Figure 2, A, and the Popoff receiver to Figure 1, B, execpt that in the latter the antenna and earth are connected to the coherer.

Señor Cervera, on behalf of the Spanish government, has designed a wireless-telegraph system that is, in some respects, different from those which preceded. While the transmitter of Cervera employs a vertical wire and grounded terminal of the open-circuit type, a condenser is inserted in either arm of the oscillator near the spark gap to increase the potential of the discharge. The receiver operates through the same antenna and ground wire as the emitter, but the changing

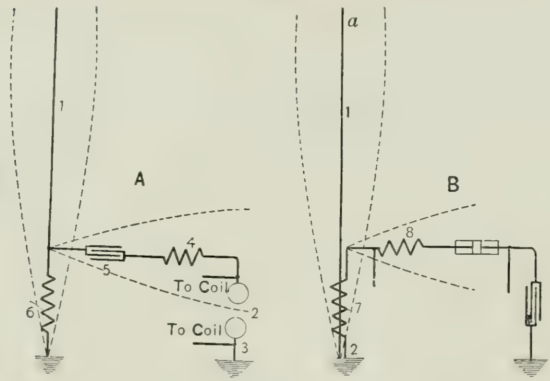


FIG. 10. DIAGRAMATIC VIEW OF SLABY-ARCO MULTIPLE-TUNED WIRELESS-TELEGRAPH TRANSMITTER AND RECEIVER.

switch is so arranged that the condensers are cut out when receiving. The distinguishing features of this apparatus are principally in the construction of the receiver. The antenna and earth are connected through the primary of a small transformer, the secondary of which is divided by cutting one convolution at the center and connecting the terminals thus formed to a condenser, and this in turn to the conductor plugs of the coherer.

The coherer consists of two small parallel ivory discs, adjusted by means of micrometer screws, and between them are the conductor plugs made of soft annealed iron forming the contacts with the powdered metal. There are four separate circuits in the Cervera receiving apparatus, each having its own source of current, and these fulfil the following functions:—(a) operating the Morse register; (b) making and breaking the coherer and relay circuit, rendering decohesion more certain; (c) actuating the tapper; and (d), interrupting the circuit of an electromagnet regulating the sensibility of the coherer. The receiving circuits are more complicated than in any other system, but the apparatus works well and has given satisfaction between testing stations at Tarifa, Mount Comorro, and Ceuta at the Castle of Huelvo across the Strait of Gibraltar, a distance of 34 kilometers.

The Slaby-Arco multiple-tuned wireless-telegraph system is based on a number of original conclusions bearing on the laws of electrical resonance. Dr. Slaby and Count Arco begin by assuming that the height of the antenna should be one-fourth the length of the emitted wave, and instead of connecting the antenna to the side of the spark gap it is grounded direct as shown in Figure 10, A; a second conclusion is that the earth forms a nodal point for the current waves, and this being accepted it is plain that a second wire equal in length to the antenna and connected to it in the earth will respond to the current waves and a wave crest or its greatest amplitude at the end of the wire equal to that at the end of the antenna, as shown by the dotted lines.

The second or auxiliary wire does not need to be of the same length, physically, as the antenna, but must represent the same inductance, capacity, and resistance; the spark gap, 2, of the induction coil is connected to one terminal of the auxiliary wire and the opposite side grounded at 3; an inductance coil 4, and condenser, 5, both of which are adjustable, serve to make it of the same dimensions, electrically, as those of the antenna. The large inductance coil, 6, serves to regulate the fundamental harmonics of the open-circuit oscillator, 1. The resonator, B, is similar to the oscillator, A, and all waves not of predetermined length are dissipated in the earth, since the nodal point would not be at the juncture of the auxiliary wire; in the receiver this wire terminates in the coherer, the opposite conductor plug of which is earthed; the coils 7 and 8 are inductances for the purpose of tuning the system, which is compounded, embodying both the open and closed-circuit oscillators and resonators, but the dividing line between them is not very well defined.

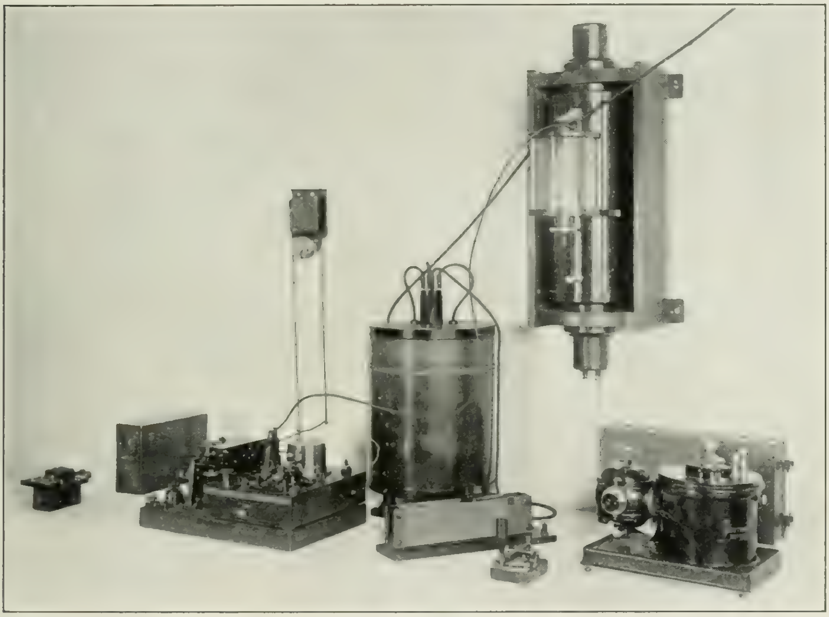


FIG. 11. SLABY-ARCO MULTIPLE-TUNED WIRELESS-TELEGRAPH APPARATUS. STANDARD STATION SET.

In the photograph, Figure 11, a complete standard station set is shown; the induction coil with the oscillator, encased in a glass vessel filled with oil, is fastened to the wall; the primary current, supplied from 110-volt circuit, is passed through a mercury turbine interrupter operated by a small motor, shown to the right; a key and variable resistance completes the transmitter. In practice the inductance coil (4, Figure 10) consists of a few turns of heavy wire wound on the outside of the condenser, 5, made up, in this case, of a number of Leyden jars (Figure 11) enclosed in a cylindrical pasteboard box. A relay, coherer, tapper, and Morse register form the principal elements of the receiver, whilst a bell, arranged in parallel with the Morse register, serves to call the operator. This system was exhibited before the German Emperor when two messages were received simultaneously from different stations.

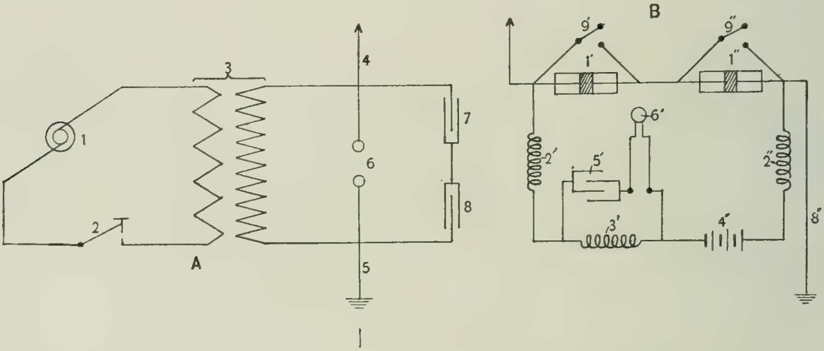


FIG. 12. DIAGRAM OF DE FOREST WIRELESS-TELEGRAPH SYSTEM.
A, transmitter; 1, alternating-current generator; 2, key; 3, oil transformer; 4, antenna; 5, ground; 6, spark gap; 7, 8, condensers. B, receiver; 1′, 1″, responders; 2′, 2″, choke coils; 3′, resistance 5,000 ohms; 4′, battery; 5′, condenser; 6′, telephone receiver; 7′, antenna; 8′, ground; 9′, 9″, shunt switches.

The De Forest wireless telegraph is an American system designed by Dr. Lee De Forest and Prof. Clarence E. Freeman, and contains several novel features. The transmitter is widely different in its construction from those employing induction coils of the Ruhmkorff type, in that a 110-volt current is transformed by a rotary transformer into an alternating current at 500 volts and this is stepped-up in an oil transformer to 25,000 volts; a condenser formed by a number of Leyden jars is charged to their maximum capacity by this low-frequency high-potential current, and the high-frequency high-potential currents are obtained by the disruptive discharge of the jars through an oscillator having the usual air gap. Figure 12, A, shows the connections of the transmitter. The antenna is connected to one side of the oscillator and the earth to the opposite side. A key for breaking the primary circuit under oil has been designed especially for high-speed work. A photograph of the sending apparatus is shown in Figure 14.

The De Forest receiver employs a detector of the electric waves

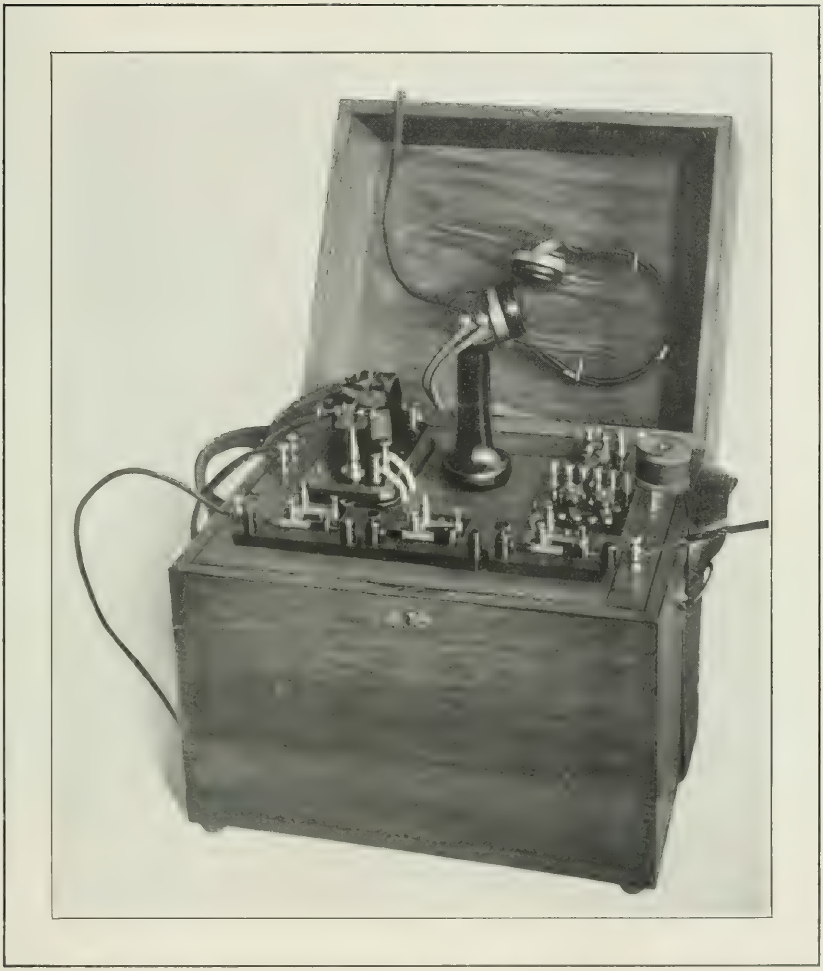


FIG. 13. DE FOREST WIRELESS-TELEGRAPH RECEIVER WITH TRIPLE RESPONDER AND HEAD TELEPHONES.

which responds to the impressed difference of potential in a manner similar to an anti-coherer, and diametrically opposite to that of an ordinary coherer; that is, it has its resistivity increased, but unlike the anti-coherer, the responder of De Forest has an internal action due to electrolysis. Unlike the receiver of Popoff-Ducretet, the circuit including the head telephones, responder, and cell of the De Forest receiver has a nominally closed local circuit, the current from the cell flowing through the telephones all the time the instrument is in operation. When the impinging wave sets up its complementary oscillation, the latter acts upon the responder and instantly its resistance is increased, the local circuit is broken, and the diaphragm, released from the pull of the magnets, produces a sharp click. In Figure 12, B, it will be observed that the antenna and earth are connected to the primary of a small transformer and the responder, cell, and telephone, forming the local circuit, are connected in series with the secondary of the transformer. This system has been very successful and this is, no doubt, largely due to its simplicity of construction. At the Jersey City station on February 22, 1902, signals were received from the Etruria when the steamer was ninety miles at sea.

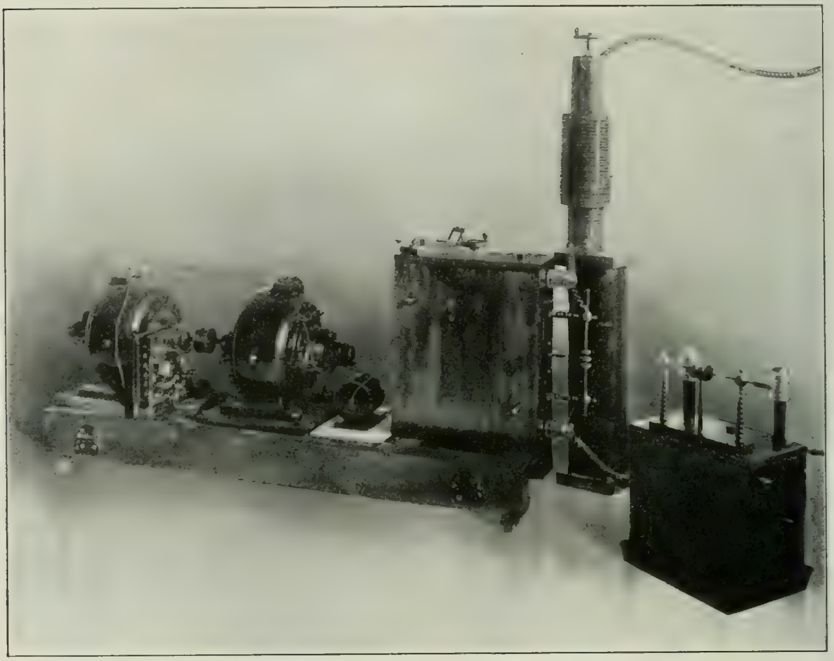


FIG. 14. DE FOREST WIRELESS-TELEGRAPH TRANSMITTER;

Showing rotary transformer, oil transformer, condensers, spark gap, and key.

In a series of patents issued to Prof. Reginald A. Fessenden, one of especial interest includes the principal features of his improvements in wireless telegraphy. The diagram, Figure 15, shows a combined sending and receiving apparatus, 1 representing the antenna, 2 an induction-coil generator, 3 a spark gap, 4 a key to throw the antenna in and out of tune, the generator being kept continuously in action, 5 a tuning device or grid formed of one or more movable contacts, shown in 6 in electrical contact with each pair of wires; these are immersed in oil.

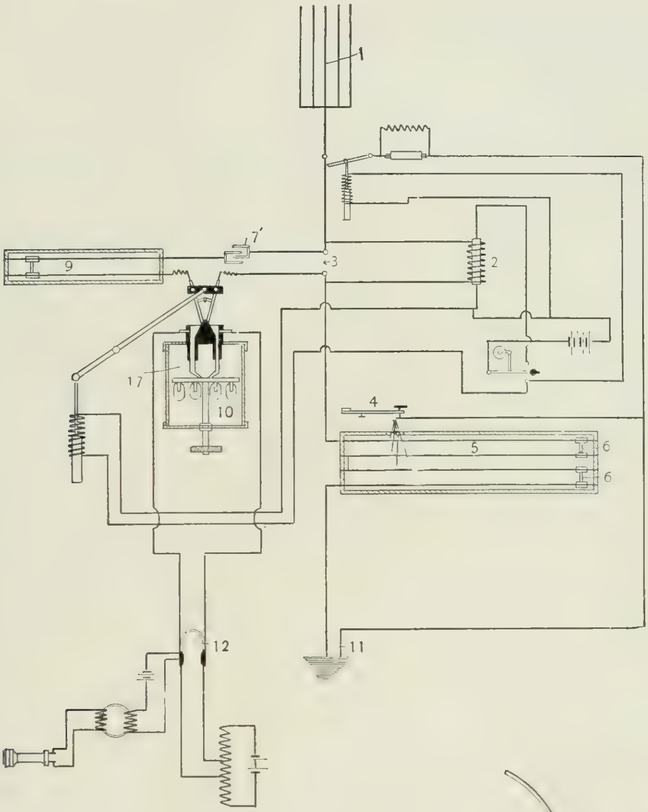


FIG. 15. FESSENDEN COMBINED SENDING AND RECEIVING APPARATUS.

The tuning grid is novel in its construction in that it combines a variable inductance and capacity without resorting to coils, condensers, or capacity areas. By adjusting the capacity and inductance, a frequency of oscillation may be obtained which exactly corresponds to the natural period of the oscillator system—which includes the antenna—and a pure sine wave is the result.

The resonator of the receiver includes the antenna 1, the condenser 7, tuning grid 9, electro-magnetic-wave detector 10, and the earth 11. The tuning grid is similar to the one employed in the oscillator system.

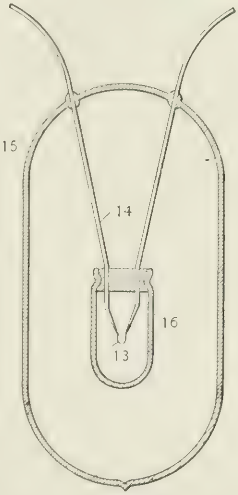


FIG. 16. FESSENDEN ELECTRIC-WAVE DETECTOR.

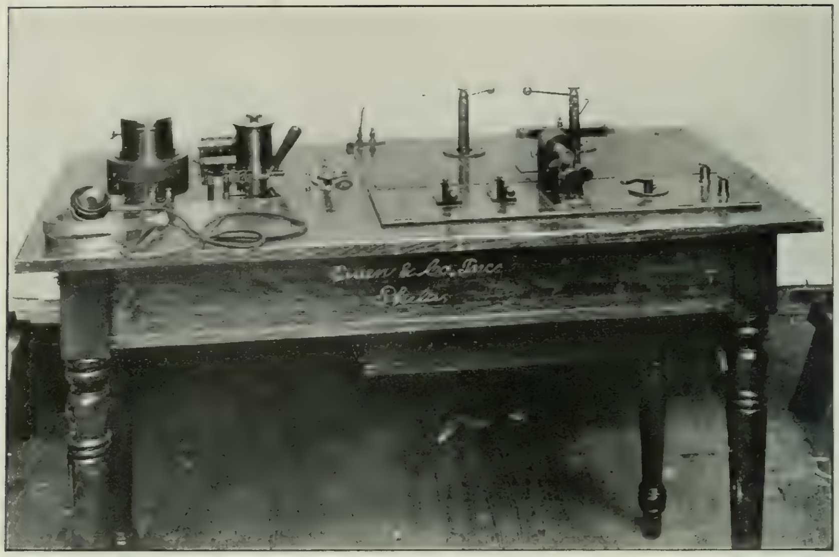


FIG. 17. RECEIVING AND TRANSMITTING APPARATUS, FESSENDEN WIRELESS-TELEGRAPH SYSTEM.

That a high speed may be obtained in receiving, Fessenden employs a pair of head telephones 12, and the detector 10, which possesses decided advantages over an ordinary self-restoring coherer, not only in being more rapid in action, but in its economical function whereby all of the energy of the received wave is utilized.

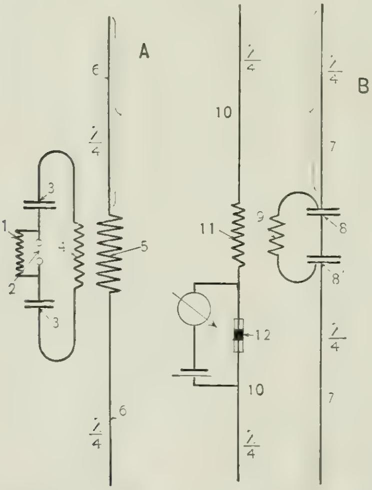


FIG. 18. SCHEMATIC ARRANGEMENT OF BRAUN'S WIRELESS-TELEGRAPH SYSTEM. A, receiver; B, transmitter.

The electric-wave detector, 10, is shown in detail in Figure 16; it is composed of a short loop of silver wire, 13, having a diameter of .002 inch, with a core of platinum wire .00006 inch in diameter and fastened to the leading-in wires, 14, these, in turn, being sealed in the glass bulb, 15. The tip of the silver loop is dissolved away by nitric acid, leaving the platinum exposed, and to decrease the loss by radiation the loop is enclosed in the silver shell, 16. The device shown at 17, Figure 15, is a holder for a number of the wave detectors just described.

Figure 17 is a photograph of the Fessenden apparatus complete, the oil break of the key and nearly all the receiving apparatus being enclosed beneath the table. This system has been thoroughly tested by the U. S. Weather Bureau, of which Prof. Fessenden has been the wireless-telegraph engineer for the past few years.

One of the best-known, though recent, systems, is that designed by Dr. F. Braun. The apparatus typifies the accrued knowledge of oscillations, electric waves, and resonance, combined with the most advanced mechanical ideas and the finest workmanship.

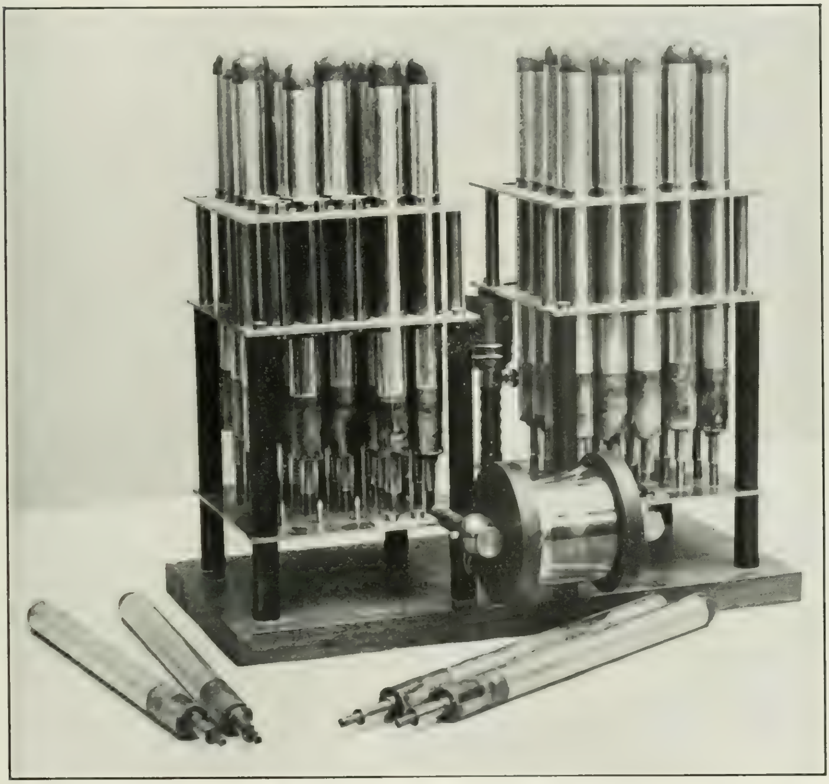


FIG. 19. BRAUN-SIEMENS & HALSKE VARIABLE CAPACITY SPARK GAP FOR OSCILLATOR SYSTEM.

A diagramatic arrangement of the oscillator and resonator systems is shown in Figure 18, A B. 1 represents the secondary winding of an induction coil, 2 the spark gap, 3, 3′ condensers, and 4 the primary of a high-tension transformer, the whole forming a closed circuit in which very persistent oscillations are produced; 5 is the secondary of the transformer, whose terminals are connected with two conductors 6, 6′,

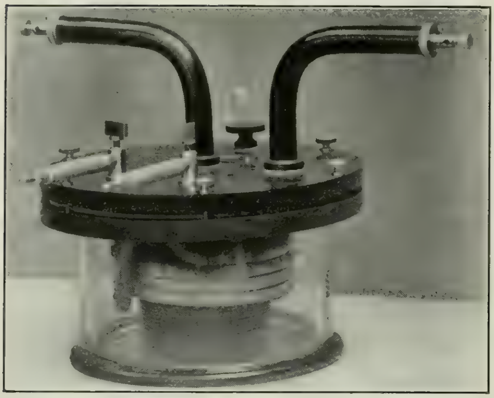


FIG. 20. BRAUN HIGH-TENSION TRANSFORMER FOR HIGH-FREQUENCY OSCILLATIONS.

both of which are one-fourth the length of the emitted wave, and forming an open-circuit oscillator system emitting powerful oscillations.

The receiver, B, consists of two vertical wires, 7, 7′, one of which is the antenna, both one-quarter the length of the received wave, and forming a closed-circuit resonator through the condensers, 8, 8′, and the primary winding of the transformer, 9; two auxiliary wires, 10, 10′, having the same length as 7, 7′, are connected to the terminals of the secondary of the transformer, 11; in one of the wires a coherer, 12, is included and from this local circuit is derived. This is the only practical system in which the earth is eliminated as a factor for tuning, capacity areas in the form of concentric cylinders being employed instead, and these make syntonic wireless telegraphy a practical fact instead of a theoretical fancy.

When in action the apparatus performs the following functions; the

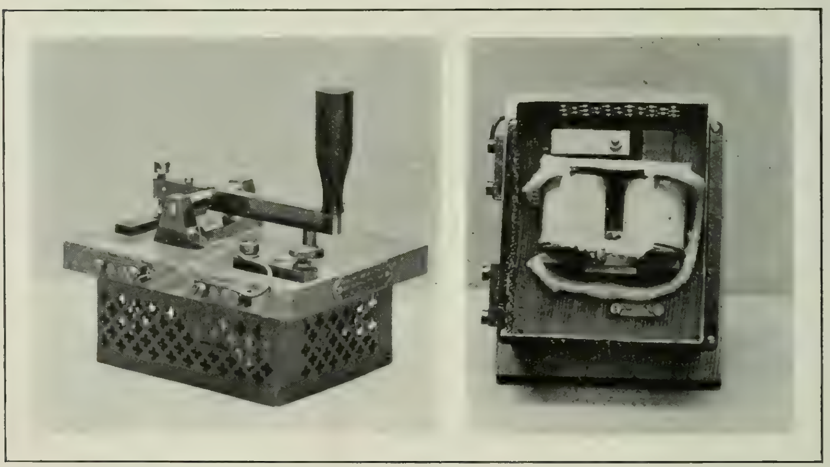


FIG. 21. THE FIGURE ON THE LEFT (a) SHOWS THE BRAUN KEY FOR BREAKING HEAVY CURRENT. THAT ON THE RIGHT (b) GIVES THE UNDERNEATH VIEW OF THE KEY, SHOWING THE MAGNETIC BLOW-OUT.

secondary of the induction coil charges the closed oscillator circuit after each disruptive discharge takes place, and the persistent oscillations thus set up are transformed into any frequency desired in the open-circuit oscillator, from which the waves are emitted very freely; the waves impinging on the closed-circuit resonator produce counter-oscillations of fundamental frequency, and these are transformed into the open-circuit, where their amplitude becomes greatest, and produce the difference of potential necessary to act on the coherer.

The accompanying photographs of the Braun system illustrate the apparatus for producing these effects. Referring to the diagram the condensers 3 3′ are arranged on a stand (Figure 19) and consist of a series of miniature Leyden jars; by this arrangement an adjustable capacity is produced; the spark gap, 2, is formed between two metal balls immersed in oil contained in the glass cylinder attached to the front of the condensers.

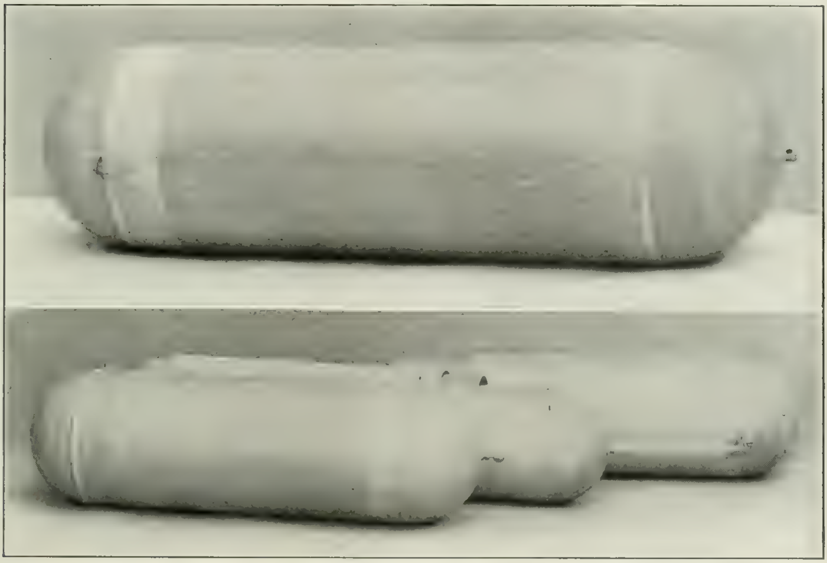


FIG. 22. CAPACITY AREAS, BRAUN-SIEMENS & HALSKE SYSTEM.
One arm of the oscillator and resonator is connected with these, instead of being grounded in the usual way.

In Figure 21, a, b, are two views of the Morse key designed for breaking heavy currents, the spark of the break due to heavy currents being eliminated by the magnetic blowout shown in b. The high-tension transformer appears in Figure 20; this gives clearly the construction of this simple but highly ingenious piece of apparatus for stepping-up oscillatory currents as depicted diagramatically at 4, 5,

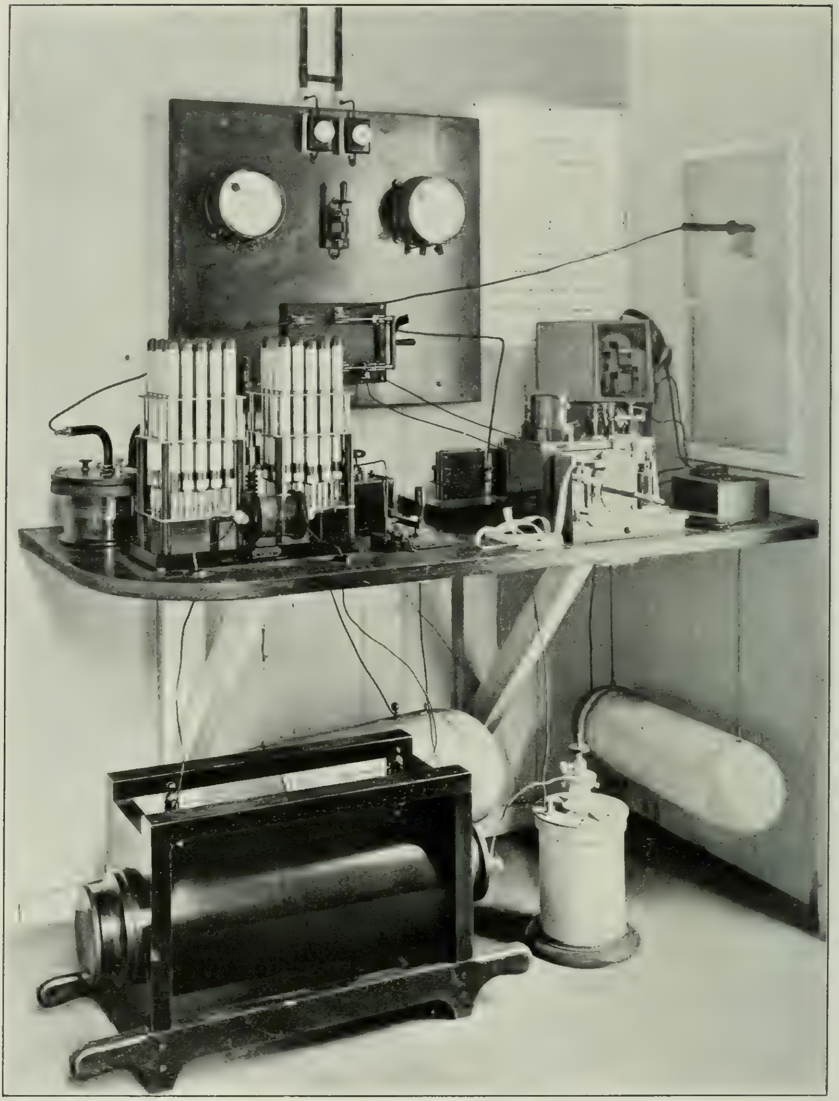


FIG. 23. BRAUN-SIEMENS & HALSKE WIRELESS-TELEGRAPH EQUIPMENT. STANDARD STATION APPARATUS.

Figure 17. The jar of the transformer contains oil when the coil is in action.

The capacities employed to take the place of the earth depicted in Figure 22 are made of copper or zinc, usually of two parts, sliding within each other, thus offering a variable capacity. The complete

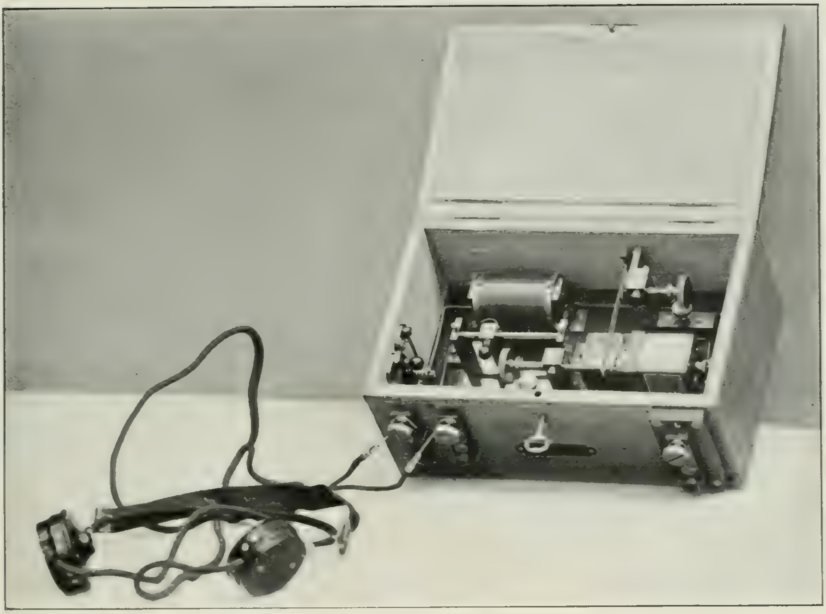


FIG. 24. THE BRAUN FIELD RECEIVER.

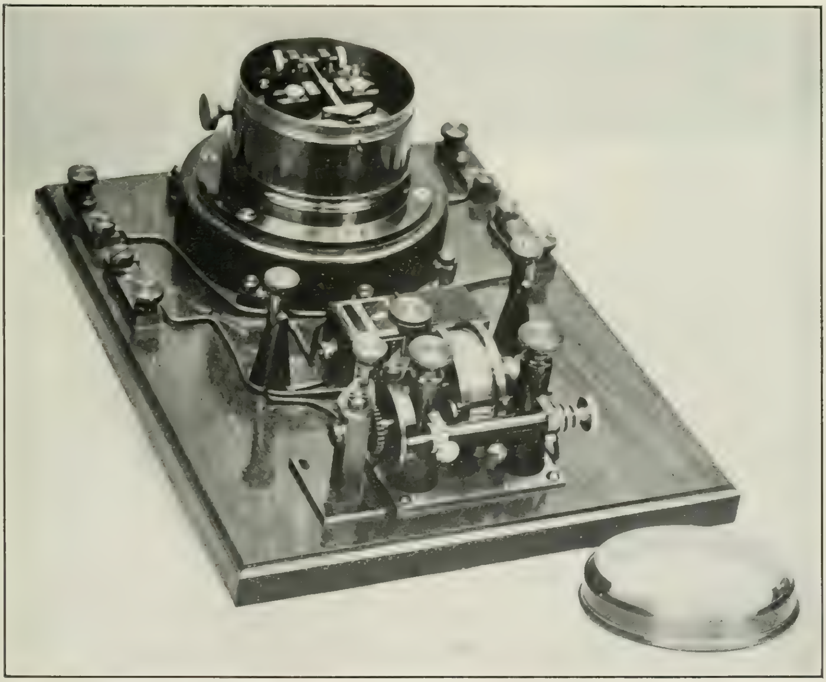


FIG. 25. BRAUN-SIEMENS & HALSKE POLARIZED RELAY ELECTRO-MECHANICAL TAPPER AND COHERER.

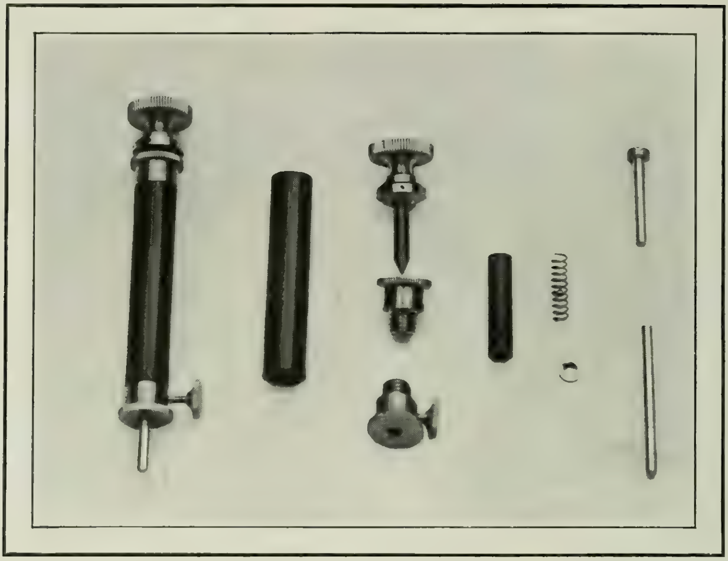


FIG. 26. THE BRAUN COHERER AND ITS COMPONENT PARTS.

sending and receiving system for a standard station is shown set up for testing prior to shipment in Figure 23, and the connections are so clearly defined they may be followed almost as easily as in a diagram. The induction coil with its accompanying electrolytic interrupter—on the floor—is operated by 110-volt current leading in to the switchboard. The secondary is connected directly to the spark gap. The large switch is for the purpose of cutting in and out the antenna from the transmitter and receiver. The small transformer for the receiver, the relay, mechanical tapper, coherer, and Morse register complete the equipment. Braun's system has met with flattering success between Helgoland in the German Ocean and Cuxhaven, a distance of 36 miles.

This represents the state of the art and the practice of signalling through space without wires to the present time. In conclusion, it is interesting to note that the letter "S" was sent and received across the Atlantic Ocean wirelessly, and that messages have been transmitted and recorded between two stations, which could not be received, intercepted or annihilated by a third station; at present the difficulties in the commercial use of such long-distance transmission and syntonic systems are many; but it portrays with vividness the ultimate scope wireless telegraphy will have in the transmission of the world's intelligence in the very near future.

THE ENGINEER CORPS IN ACTION.

# THE ENGINEER IN THE MORO CAMPAIGN.

*By an Enlisted Man in the Lake Lanoa Expedition.*

We have often urged that the engineer is the one most vitally interested in the results of the opening of new countries. The following short sketch from a participant in the current Moro campaign illustrates the fact that the engineer is also a most active participant in the acts of opening.—THE EDITORS.

ACCOUNTS of experiences of the engineering corps in modern campaigning have been written and re-written relative to the South African war, the Spanish-American war, and the war with the Filipino. But the trials, the achievements, and the general accountings of the engineers in this Moro war appear to me to be quite different from any other experiences. I served with the engineers in Cuba and with the engineers in Luzon, but never encountered tribulations such as these in this Moro campaign. The engineering corps of the army is, of course, one of the important branches so far as the progress of a column of troops in this kind of a country is concerned.

Since the beginning of operations in these southern islands, the United States have attempted to open up the rich island of Mindanao, knowing well the value of the timber lands, the products of rubber trees, and the mineral resources existing in the undeveloped interior. Detachments of soldiers were sent out toward what is known as the lake country, where for generations the Moro tribes have been invincible. Spanish troops were never able to penetrate into the lake sections and remain. They were always driven back with heavy losses by the unruly tribes of Moro fanatics, whose solemn oath is to kill all intruders, believing that if they lose their lives in the attempt, their souls will find peace in the Moro heaven. Detachments of American soldiers were often fired into when they were peacefully surveying the trails and locating positions for stockades or bridge work. On one occasion a cavalry detachment was attacked, one soldier killed and seventeen horses captured by the yelling, fighting natives. Numerous sentries guarding government properties were also shot or cut down in the darkness. Therefore about April 15 of this year it was decided to delay no longer, but to enter the lake regions with a strong force and open the country. The engineers headed the column.

"THE CORPS MAN USUALLY HAS HALF-A-DOZEN NATIVES TO DO THE LABORIOUS WORK."

I can give you some idea of the engineering work in the Mindanao expedition by describing the progress of the column to the lakes from Malabang. We had artillery on pack mules, and several pack trains to carry rations and supplies for the troops. We had to go ahead of these trains and cut away the passages. The old trails of the natives were very narrow, and had been washed out to considerable depth, so that if riding in the saddle one had oftentimes either to dismount, or to throw his feet over the horse's neck, to clear the passage. Mud was very deep everywhere. It was climb, push, and hard work for man and beast. The pack mules often caught their packs and had to be unloaded and re-packed. The engineering department went to work with a will, and with the help of several hundred friendly natives employed at fifty cents per day, and four or five hundred soldiers detailed to fell wood for corduroying the trails, the trails were put into such condition that it was possible to reach the lakes. It was about the latter part of April that we arrived at the lakes.

But the engineer in the campaign of this sort has something more to do than to build trails or erect bridges of lumber cut by the natives (and without nails or metal work of any kind available). He can turn his hand to putting the tentage and general camp into shape for the troops; he can secure gangs of hired natives and details of soldiers with which he soon ditches the camp for drainage, locates the water supply, and arranges for the putting in of a line of bamboo pipes to carry water to various points in the camps; he erects the hospital of bamboo and nipa, cuts a repository in the ground to bury the dynamite, puts up the commissary and quartermaster's shacks for temporary storage of supplies, and by the time the camp is ready to move on to the next position, he has the trails opened up some miles in advance. In fact, it is steady work for the engineers through it all.

ARMED NATIVES OF THE AUXILIARY FORCES.

Our engineer officers customarily went in advance of the head of the column daily, to make inspection for water, good camping positions, easy trails, and the like, often going with but small guard, thereby taking their lives into their hands almost daily. The ground is full of pitfalls about the lakes, and many a horse and man has fallen into these places. The camping ground must not only be near water, but it must have natural protection. Usually we look for an elevated position, controlling the country about, and then endeavor to find water near it.

This is an odd country, and many of the fixed rules of engineering in the field have to be altered. In this region the head man is the sultan, who govern a district. Under him are dozens of dattos, and each datto rules from fifty to several hundred people. Each datto has his fort or fortified stockade, made in strength according to his power and importance. The sultan's fort is always the largest and best equipped. In our advance during the months of April and part of May of this year, the column encountered very many of these forts, made of bamboo, stone, earth, and other crude material, but exceedingly strong. In a few cases these forts were either deserted or flew the white flag and were not molested. All the others flew the red flag of war and death, and opened fire on us. In most instances these forts were easily conquered, and after the Moros were driven off, the engineering corps would blow up the fort, or one end of it, with dynamite, making a grand exhibition of loose earth, stone, and wood in the air. Pandapatan was our worst fort. We attacked May 2, and before the fight ended one officer and eight enlisted men on our side were shot and killed and four officers and about fifty enlisted men wounded. We could not get into this fort. We planned to blow up one end of the fort during that terrible night, when we lay in the tall wet grass in rifle pits about thirty yards from the fort, and the natives firing into us all the time. We also made scaling ladders of bamboo. We were short of dynamite, but during the next day more came up. However, the natives surrendered on the morning of May 3 and the fight ended.

The engineering corps in the Moro campaign roughs it with the others and there is no "kicking." We carry what we can on our saddles and let it go at that. This means only a shelter half for tentage, and straight rations of food. We get wet in the morning and wet at night, and for thirty days and thirty nights I have been wet constantly, yet not a cold, or illness of any sort, for the climate is mild and even and one can drop down and sleep in wet clothes in safety.

Although engineers, we must soldier. We must be armed and when attacks come use our weapons. Engineers are not supposed to be aggressive. They are supposed to keep on with their work until molested, and then it is time to make fight.

# EDITORIAL COMMENT

The foremost matter in industrial as well as popular interest is "the settlement of the coal strike"—a settlement, by the way, which is of the strike only, and not of a single one of the differences which led up to it. It has taken five months of loss to the operators and miners and outrageous inconvenience and expense to the public, merely to induce the opposing sides to adopt the course which was the only sane one at the outset. It has taken the loss of time, and money, and blood, and life—the sacrifice of industry—the wasteful diversion of productive thought and energy—the unprecedented intervention of the head of the Nation—and finally, the rousing to the danger point of a too patient public opinion—merely to shame these mighty managers of organized capital and organized labor into a sulky adoption of measures which men whose self-magnification has not blinded them to reason would have adopted at the outset.

* * *

The points of contest it is neither needful nor timely to discuss. The best powers of a very able and conscientious commission, exerted through a long period of time, will be none too great for the solution of the primary difficulties between the men and their employers. And the very fact that this was known to and again and again stated by the principals in the fight makes the more inexcusable the reckless determination of each side to impose its own solution by force, at the expense not only of the other side but of the country at large. When dogs fight in the distant field they may perhaps be allowed to fight to a finish, and let their own wounds be their own punishment; but when they fight in the highway, hold up traffic, and make life hideous for the public, they need a sharp reminder that they are a nuisance—in this case the ammonia of public indignation in their nostrils or the hot iron of their owners' punishment to their backs.

Public ownership and operation of the mines is a dream, which would become a nightmare. Legislation may do something, but more negatively than positively—that is, more by withdrawing privileges and protections which enable abuses of position than by attempting a coercion which can be evaded by craft or hoodwinked by wealth or political influence. Compulsory arbitration is a beautiful hypothesis but a practical failure, as New Zealand bears witness. Organization cannot be prohibited without a sacrifice of individual freedom which would entail worse evils than it could prevent. The remedy must come from widespread individual enlightenment and the exercise of the enlightened individual power—by enlightened common-sense. Unless this be exercised, legislation would be a dead letter and arbitration powerless for good. That reason has made sure gain, the past struggle, deplorable as it has been, affords some evidence. Progress is slow, and it needs the comparison of observations made at long intervals to make sure that it is really advancing. But one has only to compare the anthracite strike with the railroad strikes in Pittsburgh in 1877, the Homestead strike of 1893, or the Chicago strike of 1894, to find progress, in which it must be said that labor, with all its remaining iniquities, shows greater improvement than capital.

* * *

When this wise common-sense is exercised, organization will be not a menace, but the all-efficient safeguard; for presidents, managers, and labor leaders will be controlled by the voice and the votes of the element they dare not neglect to heed—their own stockholders and constituents.

Economy will prevail in the end; the rank and file, both of workers and stockholders, will ultimately see that war is the one condition by which they are sure to lose. The class of leaders who bring on strikes or of managers who cause lockouts will be as finally discredited and retired as the class of rulers who plunge into wars. To doubt it is to deny the plain history not only of industry but of all civilization.

* * *

In nearly every labor dispute the principal question at issue has been the value which the employee should receive for his time. There is, however, another side of the question, one which does not receive the same consideration, especially from the labor organizations, namely, the value which the employer should receive for his money. In every other kind of a business transaction both sides receive equal consideration, and as a rule the two equivalents are considered in the same kind, one commodity or article of merchandise being exchanged for another, or for its exchange value in circulating medium.

In the case of the employment of labor, however, it is not uncommon to find two articles of an entirely different species being exchanged, so that it is small wonder that difficulties about the exchange equivalent occur. When money is exchanged for time, the return which the man who gives the money gets depends entirely upon the use which is made of the time—a matter which is often entirely lost sight of in the discussion. In this respect the workman has placed himself in an equivocal position, one which, for his own good, he might well hasten to abandon. So soon as he has a definite, concrete thing to sell, and not an indefinite time in which more or less may be produced, just so soon he will place himself in the position of any other business man, and be able to make a bargain dependent entirely upon the value of the goods he has to sell. This position is one which both he and his employer should make haste to welcome, since it removes the fundamental cause of differences of opinion.

* * *

The complete establishment of definite relations in labor matters involves the abandonment of the one indefinite element in the whole subject, the use of time as a measure of value. The one party should consider the time involved in the production of an article no more than the other; it is the article itself which is the thing. All bugbears about piece work would disappear if the employer paid no attention to the amount which the man was making per day, and thought only of what he paid for the piece. In like manner the workman should be at liberty to use the necessary time in the production of the given article, and make his charge for it by the market value. The only portion of the work in which the time element should enter is that which includes those things which must be measured by time, such as interest, non-productive expense, and general establishment maintenance. These are matters which the employer should compute independently of the productive labor, and distribute in his costs upon the basis of the time output of the establishment.

When the employee is looked upon in the same light as any other merchant, and the employer as any other customer, then, and not until then, can rational business methods be expected to prevail in the most important department of the world's work.

* * *

THE general interest in technical education, as indicated in leading articles and reviews in this and other issues of this Magazine, is also evident in the growth and extension of institutions devoted to instruction by correspondence. So extensively have these institutions grown that there is no doubt of their widespread influence upon the general methods of technical instruction elsewhere, as well as upon the whole problem of education for modern conditions of life. In this respect these institutions demand consideration in connection with such papers as that contributed by Sir Philip Magnus to this issue of the Magazine, or with those of Professor Dewar, Professor Perry, and Herr von Oechelhauser, reviewed in the following pages.

Apart from the correspondence feature which characterizes these schools, it must be remembered that their work is among a special *clientèle;* but it is altogether possible that some of their methods at least may influence materially the instruction of students who are able to give their entire time to educational matters. The transfer of the management of one of the large schools of correspondence to the Armour Institute, at Chicago, is an indication of the union of interests which has become apparent in this connection, and this fact especially may have an important bearing upon the whole question of technical training.

A characteristic feature of the correspondence schools is the system of text books prepared for the use of the students, and forming integral portions of the courses. These books, excellently printed, illustrated from modern sources, and well bound, contrast remarkably with the ordinary text books used in the schools. Instead of being formal, dry, and repellant, they show the student that he is "into things" from the very start. He sees illustrations of engines, dynamos, machines of all sorts, which really resemble those he sees about him, and finds that the text actually tells him something more than mere generalities about them. Instead of the collection of cuts which look as if they had been taken from the objects in a mechanical museum, he realizes that these are the subjects which he must understand, and that the rules, formulas, tables, and text really tell him how such things are designed and made, and fit him to do it himself.

* * *

ANOTHER most important feature about the correspondence school is found in the fact that the pupils really want to learn. Surprising as this fact may be, it is undoubtedly true that one of the differences between modern technical education and the old-time scholastic method—one which of itself is enough to win commendation for the new system—is that the student no longer has to be driven, pushed, crammed, or punished; he is eager to learn. That this has not always been the case is perhaps the strongest indictment which could be drawn up against the earlier methods.

There are features about the correspondence schools, however, which must be considered in comparing them with other educational institutions. In the first place they are distinctly money-making institutions, their prime object being the return of profit to the proprietors, and the methods employed for teaching are the outcome of good business sense, just such as might be employed in the preparation and sale of any other commodity. This is evident in the manner in which pupils are sought by canvassers, the country being divided up into districts and subdistricts, and worked as assiduously as is the case with any life-insurance company or any subscription book scheme. There is no real objection to this, if it be understood from the start, since the rule of *caveat emptor* may then be applied in the keenest business sense; but the fact takes the correspondence school entirely out of the category of the great educational institutions, which openly give the student a great deal more than he pays for, and look to endowments, State aid, and other outside resources to make up the deficiency.

Another great defect in the correspondence school is the fact that the personal influence of the teacher is absent. In many instances the privilege of contact with a true, enthusiastic educator is worth far more than all the verbal or written instruction that money can buy. The well-known fact that correspondence papers on technical subjects are frequently examined and corrected by mere clerks, or even by girls, working with a key, is sufficient to emphasize the magnitude of this difference.

There are undoubtedly two sides to the question, and so there is room for both kinds of institutions. The correspondence school will serve well the young man who cannot go to the day school, since it brings a good school to him, and the fact that somebody is making some money out of it is a secondary consideration in such a case. At the same time the influence upon the regular technical school may be most beneficial, in so far as the necessity for constant touch with the outside world in its latest and most practical developments is impressed. The power and scope of the correspondence school may be likened to that of the automatic machine which enables anyone who can pump the bellows to play upon the piano. The great university can be compared to the virtuoso—of incomparably greater power so far as individualization, refinement of expression, and finished technique are concerned, but correspondingly limited in what, for convenience, we might term "volume of performance."

# REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

## PROBLEMS OF TECHNICAL EDUCATION.

### THE DEFECTS OF EXISTING METHODS AND THEIR FAILURE TO MEET PRESENT AND FUTURE REQUIREMENTS.

*Notable Addresses in England and Germany.*

THE meetings of the British Association for the Advancement of Science are always of interest and importance to the engineer and technical man, not only in the proceedings of the sections especially devoted to engineering science, but also in a broader and more general way. The intimate connection of engineering with all departments of applied science, and the great extent to which engineering questions are becoming matters of everyday life to all people also render the proceedings of the Association of growing popular interest.

A notable evidence of the broadening of the scope of engineering science is seen in the extent to which it is including matters formerly considered to be outside its chosen sphere, and among these latter day questions is the fundamental one of education.

Mediaeval traditions die hard, but when they do die they become very dead indeed. Hence it follows that the efforts to wrest the control and direction of education from the hands of the successors of the schoolmen of the middle ages and transfer it to the guidance of the men who are really doing the work of the world, demand encouragement and publicity, especially when those efforts are made with such power and skill as has been exhibited in England by Perry, Dewar, and others, and on the Continent by Von Oechelhauser, Bach, and their associates.

Professor Dewar, in his presidential address, called attention to the fact that the production of the so-called "exceptional" man is not an expensive process, so far as money cost goes. The total cost of the Royal Institution for salaries and scientific research during the hundred years of its existence has been about £100,000.

During that time it has made possible the investigations of Young, Davy, Faraday, and Tyndall, to which we may add those of Professor Dewar himself, besides others whose labours appear less only by comparison. The Royal Institution has not educated these men, in the ordinary and ancient acceptation of he term, but in the modern and broader meaning of the term, it has been an educational institution of the highest order, one which has enabled these men to develope the capacities which were in them for the advancement of knowledge both for themselves and for the entire world.

Professor Perry, in his brilliant address before the engineering section of the British Association, handles the question without gloves. The absurd idea that mental discipline is best gained by putting artificial difficulties in the way of the student, he brushes aside with a few vigorous words, showing not only the abundance of opportunity for mental discipline in the natural problems which each student must meet and solve for himself, but also emphasising the fact that it is scientific habits of thought and action which it is necessary to produce, and not a mere knowledge of facts which may or may not be of future value, and which in any case may readily be found by reference.

The importance of a proper general education for the boy who is to study scientific subjects thereafter, may best be given in Professor Perry's own words:

"What we want to see is that a boy of fifteen shall be fond of reading, shall be able to compute, and shall have some knowledge of natural science; or, to put it in another way, that he shall have had mental training in the study of his own language, in the experimental study of mathematics, and in the methods of the students of natural science. Such a boy is fit to begin any ordinary profession, and whether he is to enter the church, or take up medicine or surgery, or become a soldier, every boy ought to have this kind of a training."

The most interesting thing about the whole question is that there is in progress a general awakening to the fact that men are living in a new world, a world which is as certain to make new methods and standards for itself as did the ancient and the mediaeval worlds. The men who are doing things, the men who are controlling things, who are mastering the lives of nations and dictating to their governments, these are the men by whom the methods of education are to be directed. Education, both general and technical, can no longer be held in the grasp of the dead hand; indeed the stiffened fingers are already well loosened, and life and vigor is being infused on all sides.

The situation in Germany is also interesting as regards educational matters. In England Germany is constantly quoted as a land in which technical education is maintained at a high and modern level. The presidential address of Herr von Oechelhaüser before the Verein deutscher Ingenieure, however, shows that there is room for much discussion. Commenting upon the new responsibilities which rest upon the technical educational institutions of Germany with the authority to grant degrees in engineering, bestowed by the Emperor last year, he calls attention to the necessity for the infusion of living thought and action into engineering education. Specialisation must not be permitted to stifle a broad grasp of the conduct of life and the control of men and things. Professor Bach has well shown that there are two distinct kinds of material required for the production of industrial wealth, the dead and the living. The student may be well instructed in the art of using the dead materials of which engineering products are composed, but unless he knows how to use the living material, the men by whom the work is to be done, his training is most incomplete.

All this but emphasises the fact that technical education can no longer be considered as a thing apart from education in its broader sense, it is to become the controlling element in educational work in all lands. The engineer is no longer a mere mechanic, a kind of specialised tradesman. He has become the exploiter of the world in the highest sense, at the same time constructor, economist, financier, statesman; and the education which is to fit men for such functions must be the broadest and best the brain and experience of man can devise. Mere precedents will not do in such a task. To know "what has been done, and who did it" is all right, but often merely as a means of knowing what to avoid in the future; while to know "what to do, and how to do it" must be the basis of all education in the future, not only technical but general, in the broadest sense of the term.

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# ELECTRIC LIGHTING FOR RAILWAY TRAINS.

### STEAM-TURBINE DRIVING FOR LIGHTING DYNAMOS ON EXPRESS TRAINS OF THE PRUSSIAN STATE RAILWAYS.

*Oberbaurath Wichert—Verein Deutscher Maschinen Ingenieure.*

THE use of independent engines and dynamos upon the locomotives of railway trains for the purpose of furnishing the current for lighting the carriages has been held to possess conspicuous advantages and disadvantages. Any other system requires the installation of a greater or less number of storage battery cells, and the ability to dispense with these is certainly to be welcomed.

At the same time the dependence upon mechanism attached to the locomotive, renders the train helpless, so far as current is concerned when the engine is detached.

Another, and most important objection to the independent plant is found in the general low economy of small steam engines, such engines requiring from 80 to 120 pounds of water per horse-power-hour, even when in good order.

The first objection to the independent electrical plant does not apply to long-distance express trains, making runs of 100 to 250 miles without stop, since the locomotive carrying the engine and dynamo is not detached at any time when light is required in the train. The second objection, that of excessive steam consumption, is now sought to be overcome by the employment of the steam turbine as a motor, the economy of these machines being nearly as good for small powers as for larger machines.

The various systems of electric train lighting which involve the use of a separate generator on each carriage, driven from the axle, and used in connection with a small storage battery, are by no means so simple as at first appears. As discussed in the paper of M. Guérin, in the last issue of this Magazine, special provision has to be made for the variations in the speed of the train and for the possible reversal in the direction of rotation of the dynamo, and none of the plans yet proposed has been altogether satisfactory.

At present the best results have been obtained by the use of the engine and generator mounted on the locomotive and taking its steam from the main boiler; together with a moderate equipment of storage battery in each car for the maintenance of the current during the brief periods when the locomotive may be disconnected.

In a paper recently presented before the Verein deutscher Maschinen-Ingenieure by Herr Oberbaurath Wichert, and published in *Glasers Annalen,* some account is given of the equipment of the trains of the Prussian State Railways, in which the De Laval steam turbine is used as the motive power in the independent generating plant mounted on the locomotive.

The general arrangement of the apparatus is simple. The turbine, of 20 horse power, running at 20,000 revolutions, geared down to 2,000, is attached to the same base plate as the dynamo, the whole being mounted on the top of the boiler of the locomotive, with handles operating the valves extending back into the cab of the engine, placing the entire control in the hands of the locomotive engineer.

A continuous current generator is used, operating at a pressure of 68 volts, and giving a current of 180 amperes. In connection with the generating machinery there is a storage battery of 32 cells in each car, this being capable of supplying light for about 3¼ hours in case of interruption with the generator.

The paper discusses at length the system of wiring adopted for the corridor compartment trains used on the express trains, together with the arrangement of the regulating resistances by means of which the current is maintained uniform for the varying demands.

Experiments have been made upon trains running from Stettin to Stralsund—Sassnitz, and also between Berlin and Altona, with satisfactory results, and upon these records Herr Wichert deduces some general information concerning this system of train lighting.

There is no doubt that electric lighting is by far the best for use on railway trains so far as convenience and satisfactory illumination is concerned. The brilliancy of the light is unsurpassed, the lamps can be placed in the most convenient locations for reading and for freedom from the production of dense shadows, while the general control of the illumination which can be given to the lighting of the whole train is an important feature. The air of the compartments is not vitiated, the influence of draughts of air, so important in connection with oil and gas lighting, becomes negligible. In view of these facts it is evident that only questions of cost can be opposed to the general installation of electric train lighting.

According to Herr Wichert's figures the cost of electric lighting over the use of oil gas, such as is employed in the Pintsch system for example, is about threefold. This, however, varies somewhat according to the duration of the lighting period, the cost of lighting by gas increasing much more rapidly with the increase in time than is the case with electric lighting.

While it is not to be expected that the manifest advantages of electric lighting can be obtained at the lower cost of inferior systems of illumination, yet it may be practicable to reduce the cost somewhat. Thus the steam turbines referred to by Herr Wichert were by no means so economical as they might have been, the steam consumption reaching 19 to 20 kilogrammes per horse-power-hour (about 42 to 45 pounds), but there is no reason why the steam consumption should not be about one-half this amount, judging by the recent results which have been obtained with turbines of the same construction elsewhere.

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# PRACTICAL CREMATION OF GARBAGE.

## A CRITICAL EXAMINATION OF THE PERFORMANCE OF THE REFUSE-DESTRUCTION PLANT AT TRENTON.

*Report of Mr. Rudolph Hering.*

It is now generally conceded that the proper way to dispose of garbage and house refuse is by cremation, but it is not always fully understood that a refuse destruction plant, to be fully satisfactory, should be designed and operated with the skill of the trained engineer. It is some time thought that garbage can be burned just like any other material, and the only requirements in furnace design involved are those relating to capacity and handling of material. The fallacy of such views is clearly shown in the very interesting report recently made by Mr. Rudolph Hering upon the destructor plant at Trenton, New Jersey, where the unsatisfactory performance of the installation rendered it necessary to give the matter skilled attention.

That garbage can be effectively and inoffensively burned cannot be denied, since this operation is daily carried on in various cities. Furthermore, the heat produced by the combustion of the organic matter has in numerous instances been utilized for the generation of steam to an extent which practically meets the expenses of operation of the plant. When, therefore, a disposal plant is both offensive and expensive, it is evident that the best results of engineering experience have not been secured, and that the defects must be in the execution of the idea, and not in the idea itself.

The first, and most important function of a garbage destructor is that it shall consume all the organic matter fed into it so fully and completely that there shall be no offensive odors emitted, and that no unburned particles shall escape from the furnaces. These points being completely assured, the utilization of the heat may be considered, together with the economy in fuel required for the operation of the plant. Without going into the details of the plant at Trenton, it will suffice to explain its general arrangement. The garbage is first delivered into drying chambers, where the moisture is partly drained off, after which it is raked into a combustion chamber, in which coal is burned on the grate to assist in the combustion of the organic matter. The liquid from the drying chamber is collected in an evaporating pan, and the gases evolved in the combustion chamber are passed through a flue and over auxiliary coal fires for the purpose of eliminating any odors which might otherwise remain. The ashes produced by the burned refuse are raked out by hand, when, in the judgment of the attendant the combustion is completed.

The practical working of this apparatus is about what might have been expected. The emitted gases are not free from odors, unburned particles escape up the chimney and are carried over the neighborhood together with an appreciable amount of dust, while sufficient unconsumed garbage is removed with the ashes to cause offensive odors to be produced.

To an engineer the causes of these defects appear due to obvious causes. Incomplete combustion is caused by attempts to cremate the refuse too rapidly and at too low a temperature. The carrying of dust and particles of garbage out of the chimney point to a high rate of speed of the gases through the flues, while unburned garbage in the ash is a natural consequence of the attempt to maintain a high rate of combustion in connection with unskilled attendance at the furnaces.

The long experience which has been gained in England with refuse destruction, supplemented by the scientific tests made upon plants recently erected in various parts of Germany, shows that a high temperature is necessary in order to effect complete incineration, and that sufficient time must be given to insure the entire combustion of all the organic matter. To this end the drying chamber is arranged with inclined grates, so as to deliver the material gradually to the combustion cells, while in these latter a very high heat is maintained, chiefly by means of a forced blast. By such means a complete combustion of all organic matter can be secured, if the incineration is conducted slowly enough, while the resulting clinker is altogether inorganic and odorless, and in some instances possesses a market value for cement making or for road material.

The question of the interception of dust and light material from escape by the chimney, is simply a matter of reduced velocity, easily obtained by increased cross section. This means that a properly proportioned dust chamber, with suitably arranged baffle walls, should form a feature in every refuse destructor, and if to this is added an auxiliary grate for final decomposition of the gases, the essentials of satisfactory operation are obtained.

The use of coal as an aid to the combustion of the refuse may be necessary when the material is low in combustible, or when much moisture is present. If the drying chamber is properly arranged, however, the excess moisture may be largely removed before the refuse is fed into the incinerating cell, and when the material contains unsifted ashes, it is quite practicable to complete the incineration without the use of fresh coal. This, however, is a minor question, since it is not so much high economy as complete and inoffensive cremation which is demanded. If a steam generating plant forms a portion of the installation the heat produced by the combustion of fresh coal is partially recovered, and hence it is altogether possible that in cases where the garbage is low in combustible material the design should include a steam raising plant and additional fuel consumption as an element of economy.

The most important features of the whole subject appear in the evident necessity for the use of a high degree of engineering skill in the original design of a destructor plant, together with the employment of skilled firemen in its operation. To assume that a form of destructor which has operated well in one situation will necessarily do well in another, is altogether unwarranted. Each location should be examined on its merits, all the conditions being considered for a period sufficiently long to enable not only average, but exceptional features to be determined. The plant should be designed by engineers familiar with the principles of combustion and the requirements of the situation, and it should be operated by trained firemen and not by ignorant laborers.

There is no difficulty whatever in the complete and satisfactory cremation of refuse within city limits in a manner altogether inoffensive and frequently profitable, but the work must be done by engineers and not by politicians or ordinary mechanics.

## MILITARY AUTOMOBILES.

### THE GREAT DESIRABILITY OF A SUITABLE INTERNAL-COMBUSTION MOTOR FOR SELF-PROPELLED MILITARY VEHICLES.

*Report of the War Office Committee.*

LAST February the motor trials made before the War Office Committee in the course of its investigations upon the suitability of automobile vehicles for military service were reviewed at length in these columns from unofficial reports in various technical journals. Now we have the official report of these same trials, and find it a most interesting document in view of the recommendations contained therein, these, of course, being lacking in any previous discussion.

It will be remembered that the requirements limited the trials to vehicles capable of hauling loads of 5 tons net, of which 3 tons was to be carried on the lorry itself, and 2 tons on a trailer, the fuel and water being additional. But five vehicles actually took part in the trials, four of these being propelled by steam, and one only by an internal-combustion motor, this latter being entered by Milnes & Co., and equipped with a Daimler motor. Although all the various vehicles were installed at one time or another during the trials, this was only to be expected in view of the difficult ground and the severity of the tests. Since it was the intention of the committee to find out just which conditions were likely to interfere with the working of motor lorries in cross-country work the trials were arranged with that end in view.

The final report, some extracts from which are appended, brings out some interesting features. In the first place, although the steam vehicles did the best work in the trials, it is seen that the internal combustion motor appealed to the military experience of the judges very strongly, the independence of water supply, and the high fuel economy, being considered most valuable points. At the same time the use of highly inflammable fuels, such as gasoline, or petrol, is held to be out of the question, and heavy oil alone can be considered. This conclusion may lead to the development of an engine along the lines of the Diesel motor, since we understand that Herr Diesel has already equipped an automobile with his motor, and its capability of burning anything in the line of heavy liquid fuel should render it especially suitable for the exigencies of military service.

Another most important point in the report is the emphasis which it lays upon the demonstration of the fact that the existing road regulations are unnecessary for properly constructed vehicles. This may have a most important influence upon the general design of motor lorries for all kinds of service, and is most encouraging.

The following extracts from the official report will be of interest:

"The trials have shown that these steam lorries are good and serviceable machines suitable for present supply, and likely to be of good advantage to the transport service in countries where fuel and water in sufficient quantity is available. The committee, however, desire to call attention to the great possibilities for military purposes of the internal combustion lorry burning heavy oil, as shown by the small fuel consumption and practical independence of water of the one which was tried, belonging to George F. Milnes and Company, Limited. The committee strongly recommends that steps to develop such lorries be proceeded with.

"Compared with horse-draught, these trials have shown that self-propelled lorries can transport five tons of stores at about six miles an hour over very considerable distances on hilly, average English roads under winter conditions. The load transported by each single lorry (five tons), if carried in horse-wagons of service pattern would overload three G. S. wagons, requiring twelve draught horses, besides riding horses, whose pace would not ordinarily exceed three miles an hour. Moreover, the marching of 197 miles in six consecutive days over hilly roads would not have been accomplished by horses even at that speed without the assistance of spare horses.

"The committee are of opinion that it has been demonstrated that mechanical transport of this nature has many advantages, and that it is well worth a much more extended trial.

"Regarding the type of lorry, the experience gained at these trials has caused the committee to somewhat modify their original views. On more than one occasion the disadvantage of the trailer in preventing the lorry from moving freely backwards when required was clearly noticeable. On the whole the committee consider that a lorry drawing a single wagon, while having the disadvantages accruing from the use of a trailer, does not obtain, owing to there being only one of these vehicles, the full advantages which should belong to the system, and they consider that for handy and rapid work of distribution among troops and near the front of an army a lorry without trailer is preferable. At the same time they consider that for the heavier work of moving stores in large quantities to the depots a powerful tractor, drawing a train of wagons behind it will be found most suitable.

"The committee therefore recommend that they be empowered to take steps to obtain for trial a lorry or lorries on the following lines:

"To carry three tons, driven by an internal combustion engine burning heavy oil only; weight as light as consistent with due adhesion; wheels large and broad, and fitted with a means for rapidly applying numerous 'spuds' for use on boggy ground. Speed up to eight miles an hour; large platform area.

"Finally, the committee beg to call special attention to the demonstration afforded by these trials of the entire harmlessness to roads of vehicles considerably exceeding in weight and road-speed the limits allowed by the present regulations on the subject, and also fitted with wheels to which road strips have been fixed, so long as these wheels are of large diameter and have tyres of considerable width. It has now been proved that the existing regulations are unnecessarily restrictive, whilst they stand in the way of the development of a most important method of transport and branch of industry.

"The committee strongly recommend that this matter be brought to the notice of the proper authorities, feeling confident that the removal of these restrictions will tend to assimilate the commercial and military types of vehicles, and is not only important therefore from a service point of view, but also will have a most beneficial effect on the manufacturing industries of the country and its commercial development generally."

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# THE SAULT SAINTE MARIE POWER PLANT.

### THE COMPLETION OF THE GREAT HYDRAULIC POWER PLANT AT THE OUTLET OF LAKE SUPERIOR.

*H. Von Schon, in Engineering News.*

IT has frequently been assumed that cheap power is a controlling element in the location of manufacturing establishments, but it is by no means so important as to outweigh other considerations. When, however, we take into account the electro-chemical industries of recent development, the cost of power is found to be so essential a feature as to render it the principal element in the selection of a site.

This fact has doubtless done much to aid in the development of the important hydraulic power plant at the Sault Sainte Marie, the well-known rapids at the outlet of Lake Superior, since the situation is otherwise too remote from manufacturing centres to render it desirable for general industries.

The Sault Sainte Marie is the name given to the rapids of the St. Mary's river, a sandstone ledge in the river producing a fall of about 20 feet in a length of about half-a-mile. The fall is thus only moderate, but the large volume of water discharged, varying between 3,600,000 to 7,000,000 cubic feet per minute, renders the location well adapted for the utilization of a large power. On each side of the rapids there are already canals for the accommodation of the lake navigation, and it is well known that through these canals there passes, during the season of navigation, the largest tonnage traffic of any body of water in the world.

Naturally this large water-power has attracted attention of hydraulic engineers for a long time, since it required only the cutting of a comparatively short canal to render about 50,000 horse power available. It was not until about four years ago, however, that the progress of the appropriate manufacturing industries rendered the construction of a power plant advisable, and it was in 1898 that the work was actually commenced.

From an account of the completed work by Mr. H. von Schon, the engineer who has carried the works to a successful termination, published in a recent issue of *Engineering News,* we review here briefly the salient features of this important undertaking. The total length of the canal is about 10,000 feet, cut partly through sand, and gravel and partly through sandstone. Portions of the channel are therefore confined by walls of masonry resting on timber crib-work, while the remainder has vertical sides cut through the rock. In order to insure a smooth and permanent channel, the sections of the canal passing through sand and clay have been lined with timber planking, not only on the sides but also on the bottom, this lining connecting with the surfaces of the stone portion of the channel. This construction secures a perfectly smooth section throughout the whole canal, materially decreasing the resistance to the flow of the water, a matter of considerable importance with so long a canal having so low a head of water for utilization. This uniformity of cross section is important, not only for the reduction of surface friction, but also for the diminution of eddies and swirls in the water, it now being well recognized that the losses due to the internal work of the water caused by undulations and irregularities in the bed form a large proportion of the resistance to the water flow in a canal.

The cross section of the canal below the water line is 4,800 square feet in the intake, 4,600 feet in the rock channel, and 4,300 feet in the timber-lined sections. With the power house running at its full capacity the velocity of flow will be about 4½ miles per hour, delivering approximately 30,000 cubic feet of water per second, and enabling the turbines to develope about 60,000 horse power.

In order that the flow of water through the canal shall not alter the level of the water in Lake Superior, the government has required the company to construct compensating works in the St. Mary's river. These works include a dam, extending 2,000 feet out from the Canadian shore, this dam containing four Stoney sluice gates by which the outlet for water may be regulated according to the season.

The power house, which is placed in a forebay closing the outlet of the canal into the St. Mary's river below the rapids, contains eighty-one chambers of concrete, each equipped with one generating unit. Each hydraulic unit consists of four 33 inch turbines arranged in two pairs on one horizontal shaft, the shaft passing through a steel plate bulkhead into the generator room, and the electric generator being carried upon the prolongation of the turbine shaft. Each hydraulic unit is designed to use 391 cubic feet of water per second, at an effective head of 16 feet, developing 568 horse power and driving a dynamo of 400 kilowatts capacity.

The total cost of this important work approximates about four millions of dollars, and it has required about four years in its execution.

As already indicated, the application of the 50,000 to 60,000 horse power thus derived from the water of Lake Superior must be found in the development of new industries, drawn to the site by the advantage of cheap power. The experience of the great hydraulic plant at Niagara Falls has shown that much more is to be expected from electro-chemical industries than from any existing lines of work. In fact the existence of abundant water power has done much to render possible on a commercial scale operations already well known in the laboratory, but previously impracticable from a business standpoint. Now that calcium carbide, carborundum, graphite, aluminum, caustic alkalies, nitric acid, etc., etc., are directly produced by the electric current there is no need to induce manufacturing industries involving a proportionally small amount of power to migrate to the "Soo." Doubtless a new settlement will spring up, as there has at Niagara, another example of the fact that facilities create business as well as traffic.

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# TECHNICAL APPLICATIONS OF ALCOHOL.

## ITS USES AS A SOURCE OF HEAT, LIGHT, AND MOTIVE POWER, BASED UPON RECENT DEVELOPMENTS IN FRANCE.

*Society for the Encouragement of National Industry.*

In view of the importance of providing an outlet for the large production of alcohol in the arts there have been various attempts made of late in France to develope industrial applications of the product, several exhibitions having been made of apparatus devised for this purpose. In order to place the subject before the industrial and commercial world in a scientific and authoritative light the matter has been taken up by the Société d'Encouragement pour l'Industrie Nationale, and the reports of MM. Lindet and Ringelmann, members of the Council, to the society appear in a recent issue of its *Bulletin.*

It is understood, doubtless, that the principal element in the price of alcohol appears in the tax which is placed upon it in most countries. When, however, by means of an admixture of gasoline, benzine, or some similar ingredient it is made wholly unfit for human consumption, this element of cost may be removed, and from its high calorific power alcohol may take an important position as an industrial combustible.

So far as use as an illuminant is concerned, alcohol requires the employment of some form of incandescent mantle, in order that the heat may be converted efficiently into light. A variety of such lamps has been made, the principal forms including a reservoir for the alcohol, a wick to produce a suitable flame, and such an arrangement of chimney draught as to give a combustion intense enough to raise the mantle to full incandescence. In one form a metallic thimble is placed above the wick to retain sufficient heat to aid in vaporising the fuel before burning, but such devices do not appear to be generally necessary. Some lamps have been made to burn a highly carburetted alcohol, with the intention of supplying sufficient incandescent carbon to avoid the necessity for use of a mantle, but these are adapted for moderate lights only.

A more important class of lamps includes those of higher power, suitable for street and public lighting in situations where illuminating gas is not available. They operate by the gasification of the alcohol, either by derivation of a portion of the flame, or by a regenerative device in connection with the main burner, the alcohol being supplied under pressure, and the intense heat thus produced being employed upon one or more incandescent mantles. Such lamps offer numerous advantages for situations where gas or electric distribution is not available, the light being much more intense than that of ordinary gas burners.

The report of M. Lindet contains full tabulated data and results of tests of fuel-consumption and illuminating power of the various lamps. The luminous power varies greatly with the extent to which the alcohol is mixed with other hydrocarbons, with the pressure employed, and with the size of the lamp, the large lamps consuming less than one cubic centimetre per candle-power-hour, while for the small lamps the consumption in some instances rose to more than four cubic centimetres.

The use of alcohol in internal-combustion motors is a matter of much interest, since the increasing use of such machines for the propulsion of automobiles, launches, etc., offers a wide field for the disposal of a large part of the product.

Numerous trials were made upon motors, independently of the applications to which they may be put, each trial being made with two kinds of fuel, pure methylated alcohol, and alcohol carburetted 50 per cent. These tests confirmed the results made in the trials in 1901, namely that under the same conditions of operation, the consumption of alcohol carburetted 50 per cent. is 0.7 that of pure alcohol, this holding good for six different motors developing from 5 to 35 horse power. The principal feature demanding attention in motors to use alcohol fuel is the carburetter, this requiring careful adjustment to supply the proper proportion of carburetted air to the motor to secure the best results. The lowest fuel consumptions were obtained with the motors operated at moderate rotative speeds, the economy diminishing with increase in speed, this probably being due to the time required for complete combustion.

Doubtless this result could be modified by using an increased degree of compression, and there is every reason to believe that with motors especially designed and proportioned for use with alcohol fuel, in the light of the recent experiments, good economy at high speeds could be secured.

Certain tests were made upon automobiles using alcohol fuel, the machines being placed upon dynamometer brakes to supply the measured resistance, the tractive power being measured by receiving the pull upon a spring balance. With a speed corresponding to 16 kilometres per hour, exerting 3.69 horse power, the consumption was 1.73 kilogrammes, while for a speed of 29 kilometres, and a development of 4.93 horse power, the consumption rose to 3.03 kilogrammes. Experiments with boats on the Seine confirmed these results, the consumption increasing with the speed.

There appears to be little doubt that the several applications of alcohol for the production of light, heat and power have been demonstrated as to practicability to an extent sufficient to warrant the assertion that any reasonable output will find a satisfactory market.

# PROGRESS OF THE NEW TECHNICAL DICTIONARY.

PROVISIONAL REPORT OF THE EDITOR OF THE "TECHNOLEXICON," THE NEW FRENCH-GERMAN-ENGLISH TECHNICAL DICTIONARY.

*Dr. Hubert Jansen—Verein Deutscher Ingenieure.*

SEVERAL years ago it was suggested in these columns that the defects in existing technical dictionaries demanded the production of a new and improved work, and it was then proposed that the various technical and professional societies in England, France, Germany and the United States should take up this work. Shortly afterwards the Verein deutscher Ingenieure announced its intention of preparing a dictionary of technical and mechanical terms in English, French, and German, and called upon the professional societies of other countries to lend whatever aid might be available, so far as the preparation of the copy was concerned. The German society proposed to bear all the financial responsibility itself, and it has well borne out this idea, having appointed Dr. Hubert Jansen as Editor-in-Chief and pushing the work forward continually.

At the recent meeting of the Verein deutscher Ingenieure at Düsseldorf, Dr. Jansen made a progress report, from which we make some abstracts, giving an idea of the magnitude and extent of this most important work, as well as the efforts which are being made to carry it through.

Thanks to the energetic efforts of the management, there are now interested in the work, according to the record at the close of June, 1902, 316 technical societies, of which 266 are in Germany, 25 in England and America, and 25 in France. There are also 1,754 independent collaborators at work, 1,333 in Germany, 229 in England and America, and 192 in France. Various circulars, note books, and instructions have been sent out, and the work has been prosecuted in a most systematic manner from the start. Dr. Jansen estimates that the collection of the material will be accomplished by the close of 1904, and that the final revision and publication will bring the completion of the work to the close of the year 1906.

From the provisional account of the work, as given by Dr. Jansen in his report, some interesting notes may be given. In the first place the work is a dictionary, not a technical encyclopaedia. Its primary service is to be an aid to translation, and this limit must be kept in mind in criticising the work. Three volumes are to be issued: German, French, English; French, German, English; and English, German, French; the name "Technolexicon" having been chosen for the whole work. Especial attention has been given to the compilation of words from trade catalogues and lists, while the attempt has been made to secure all existing technical dictionaries in the respective languages for comparison and reference. This portion of the work is still in progress, and the contribution of trade catalogues, even if in but one of the three languages under consideration, is solicited by the editor.

In order that some general idea of the nature of the work may be obtained, Dr. Jansen gives some examples, showing the method of arrangement and classification which has been adopted.

As a rule the attempt will be to give the correct equivalent words or expressions translating the technical terms of each one of the languages into the two others. Definitions, explanations and sketches will be given only when absolutely imperative, this being especially the case of dialetical, rare, obsolete, quite new or little known expressions. Usually it is considered that a statement of the thing, machine, or operation of which the word under consideration forms a part, will be sufficient to determine its identity beyond doubt. This treatment of the work is being greatly facilitated by the preliminary preparation of lists of words belonging to the various trades, professions, and industries, so that the usage of a word determines its classification.

Although it is altogether too soon to make any criticism of the work, especially as criticism of an unfinished undertaking is apt to be unsatisfactory, it may be permitted to call attention to some points in connection with the examples which Dr. Jansen submitted in his report.

Thus the translation of the German

"steigung" or "ganghöhe," referring to screw threads, is, in English properly "pitch," this being much more used than "lead." The limitation of "pitch" to the number of threads per inch, does not agree with the best practice, "pitch" distinctly meaning the distance from one thread to the next turn of the same thread. This will be seen when double or triple-thread screws are considered, the number of threads counted per inch being distinctly not the pitch.

Again the translation of the word "schablone" by "standard" in the sense of standardized work, is hardly the best that could be made. Strictly speaking "schablone" means a "template," the device by means of which manifold standardized and interchangeable parts are made, but the better equivalent for the English word "standard" is the term "normalien" already in extensive use in connection with electrical and mechanical reference standards.

Instead of the term "bessemering" it is more general in English to use the word "bessemerising." These, and a few other expressions which might be noticed show that in the final revision of the work a careful editing should be given by competent specialist editors of the nationality of each of the three languages, and doubtless this will be done.

In this connection attention may be directed to the differences which exist in shop terms in England and in America, the same things being called by different names. The use of belt for strap, of Moncky wrench for screw key, etc., will serve as examples which might be included.

The whole work is of such importance that this progress report is most welcome, and it is to be hoped that the general call which has been issued for manufacturers' catalogues, lists of words, titles of dictionaries and vocabularies, etc., etc., will meet with prompt and numerous responses from engineers and manufacturers all over the world.

## THE PRODUCTION OF LOW TEMPERATURES.

### HOW THE ABSOLUTE ZERO IS BEING CLOSELY APPROACHED IN THE LIQUEFACTION OF HYDROGEN AND HELIUM.

*Presidential Address of Professor Dewar.*

AMONG the scientific researches of recent times there are few of greater interest than those connected with the production of extremely low temperatures, including the effects which such conditions produce upon well known substances. The results of recent investigations have been recorded from time to time in the pages of the technical and scientific papers, and now we have, in the presidential address before the Belfast meeting of the British Association for the Advancement of Science, a summary of the present state of information upon this fascinating subject from the lips of Professor Dewar, who himself, has been one of the ablest and most successful workers in this field.

The production of low temperatures by artificial means resembles in one respect that other frigid problem, the search for the North Pole in that it has an ultimate goal before the investigator, to reach which is to achieve world-wide fame. According to the theory of the expansion of gases, confirmed by the investigations of Kelvin upon the relations of heat and work, a gas contracts 1/273 part of its volume for a reduction of one degree centigrade in temperature. From this results the determination of the so-called absolute zero at a point 273 dgrees below the common zero or melting point of ice, and it is to the attainment of the absolute zero and a study of the behaviour of various forms of matter at that temperature that much study and effort has been directed.

Professor Dewar reviews rapidly the work of early experimenters in this field, calling attention to the little known work of Amontons at the beginning of the eighteenth century, and coming down to the modern period, after the production and properties of liquid carbonic acid became known. By the use of this agent Faraday succeeded in producing temperatures as low as 110°C., and by combining this low temperature with pressure all the gases were liquefied by the close of 1844 with the exception of the three elementary gases, hydrogen, nitrogen, and oxygen, and three compound gases carbonic oxide, marsh gas, and nitric oxide.

Further progress in the reduction of temperature was impeded by the difficulties in connection with the protection of the cooled substances from the external heat. As Professor Dewar well puts it the production of liquid air in the atmosphere of an ordinary laboratory is a feat analagous to the production of liquid water starting from steam at a white heat, and working with all the implements and surroundings at the same high temperature. The problem was not so much how to produce intense cold as how to save it when produced from being immediately levelled up by the relatively superheated surroundings. This portion of the problem was solved by Professor Dewar himself by keeping the liquefied gases in vessels having double walls, the annular space between being very highly exhausted. By coating the inner walls with a bright deposit of silver the influx of heat was still further reduced, and thus the ingoing heat was brought down to about 3 per cent. of what it would otherwise have been.

The application, by Linde, of the so-called counter-current apparatus, uniting the cooling action of an expanding gas with mechanical compression, made the production of liquid air possible, and using this as a fresh refrigerating agent, furnished material for attack of the problem of the liquefaction of hydrogen. This feat was accomplished by Dewar himself in 1898, and the product, as described by him, is a most interesting substance.

"Liquid hydrogen is a colorless transparent body of extraordinary intrinsic interest. It has a clearly defined surface, is easily seen, drops well, in spite of the fact that its surface tension is only the thirty fifth part of that of water, or about one-fifth that of liquid air, and can be poured easily from vessel to vessel. The liquid does not conduct electricity, and, if anything, is slightly diamagnetic. Compared with an equal volume of liquid air, it requires only one-fifth the quantity of heat for vaporisation; on the other hand, its specific heat is ten times that of liquid air or five times that of water. The coefficient of expansion of the fluid is remarkable, being about ten times that of gas; it is by far the lightest liquid known to exist, its density being only one-fourteenth that of water; the lightest liquid previously known was liquid marsh gas, which is six times heavier. The only solid which has so small density as to float upon its surface is a piece of pith wood. It is by far the coolest liquid known. At ordinary atmospheric pressure it boils at minus 252.5 deg., or 20.5 deg. absolute. The critical point of the liquid is about 29 deg. absolute, and the critical pressure not more than fifteen atmospheres. The vapour of the hydrogen arising from the liquid has nearly the density of air—that is, it is fourteen times that of the gas at the ordinary tem perature. Reduction of the pressure by an air pump brings down the temperature to minus 258 deg., when the liquid becomes a solid resembling frozen foam, and this by further exhaustion is cooled to minus 260 deg., or 13 deg. absolute, which is the lowest steady temperature that has been reached. The solid may also be got in the form of a clear transparent ice, melting at about 15 deg. absolute, under a pressure of 55 mm., possessing the unique density of one-eleventh that of water. Such cold involves the solidification of every gaseous substance but one that is at present definitely known to the chemist, and so liquid hydrogen introduces the investigator to a world of solid bodies."

The next step towards the absolute zero is to find another gas more volatile than hydrogen, and this occurs with helium. While this has not yet been liquefied it may be so, provided its critical point is not below 8 degrees absolute. If a sufficiently low temperature cannot be reached by the use of liquid hydrogen, it may be attained by the mechanical production of cold by the performance of external work. In any event it is probable that there exist gases other than helium of greater volatility than hydrogen; and it is extremely improbable that the absolute zero will ever be reached by man.

It may be asked, of what use is all this striving to attain low temperatures? but such a question might have been asked of many lines of scientific research which have developed ultimately beyond all conceivable expectations. The researches of Faraday in electricity and magnetism never passed beyond the laboratory stage in his hands, yet upon them is based the whole of modern commercial electrical engineering, and similar comparisons might be made in nearly every department of applied science.

There need never be any fear that the domain of science will become exhausted, or that the limits of Nature will be reached.

"The battlefields of science are the centres of a perpetual warfare, in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of Nature. To serve in the scientific army, to have shown some initiative, and to be rewarded by the consciousness that in the eyes of his comrades he bears the accredited accolade of successful endeavour, is enough to satisfy the legitimate ambition of every earnest student of Nature. The real warranty that the march of progress in the future will be as glorious as in the past lies in the perpetual reinforcement of the scientific ranks by recruits animated by such a spirit, and proud to obtain such a reward."

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# ALLOYS OF ALUMINUM.

## APPLICATIONS OF METHODS OF METALLOGRAPHY TO THE STUDY OF ALLOYS OF ALUMINUM WITH OTHER METALS OF CONSTRUCTION.

*M. Leon Guillet in Bulletin de la Société d'Encouragement.*

AFTER the development of the electrical methods of isolating metallic aluminum, about ten years ago, much was said about the uses of the metal in the arts, its principal property of value being thought to be its low specific gravity. It soon appeared that this was of less importance than had been at first considered, the fact being that, weight for weight, aluminum is about equivalent to steel, being about one-third the specific gravity and also about one-third the tensile strength. Nevertheless aluminum has found an important place among the materials of the engineer, mainly in connection with other metals, the properties which it imparts to alloys rendering it extremely useful.

With the development of the methods of metallography, in which the structural constitution of metals and metallic alloys is examined by the microscope upon polished and etched sections, much has been done to advance to employment of special alloys. The critical study of the alloys of aluminum, contributed to the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, by M. Leon Guillet, contains much information of interest upon this subject.

M. Guillet also gives some valuable details concerning the Goldschmidt process of obtaining very high temperatures by the combustion of metallic aluminum, his paper forming on the whole a discussion of the general industrial properties of the metal.

Taking advantage of the high temperature produced by the combustion of metallic aluminum, M. Guillet has employed it to effect at one and the same time the reduction of the special metal which he desired to alloy with the aluminum and to make the alloy, the result being the production of a number of alloys not generally used. These he has then examined by the processes of metallography, and he results form a complete record of the available alloy of the series.

M. Guillet describes in details the methods which he employed, these briefly consisting of the preparation of the oxide of the metal to be alloyed with the aluminum, in a fine powder, mixing it with the aluminum, the latter usually being in fine grains, thoroughly washed with ether to remove any traces of grease. This mixture was packed in a crucible and ignited by a fuse consisting of a mixture of aluminum powder and binoxide of barium, touched off by a match. After the fused mass had cooled, the crucible was broken and a metallic mass was found, usually enveloped in crystals of corundum. This mass consisted of an alloy of the metal reduced from its oxide, with a portion of the aluminum of the charge, and this was then polished, etched, and its constitution and composition studied.

In his original paper M. Guillet devotes successive chapters to detailed descriptions of the various alloys produced in this way, and for these details the interested reader must be referred to the original memoir, space here limiting us to a resumé of his conclusions.

Taking up some of the more important combinations studied, the following special properties may be noted:

Alloys of aluminum and tungsten, containing more than 58 per cent. of tungsten, proved to be very hard, but also extremely brittle. The same was found true of alloys of aluminum and molybdenum, and in the alloys of the latter, containing a high proportion of aluminum there appeared a tendency to an allotropic modification, causing the alloy to crumble rapidly to powder.

The various alloys of aluminum and tin were found to be very malleable and readily crushed, but those of uranium and aluminum on the contrary, were both hard and brittle.

The alloys of iron and aluminum containing more than 65 per cent. of iron were quite malleable, as were also those of aluminum and manganese.

Among the interesting combinations were the alloys of aluminum and nickel. Alloys containing from 50 to 80 per cent. of nickel were found to be very brittle, slowly falling to powder; while those containing from 80 to 95 per cent. of nickel exhibited a high degree of hardness, the maximum hardness being attained at 83 per cent. of nickel. Similar results were obtained with the alloys of cobalt and aluminum. From 42 to 83 per cent. of cobalt an extreme degree of brittleness was developed, while for combinations between 83 and 98 per cent. of cobalt a remarkably high degree of hardness was obtained, the greatest hardness appearing with 87 per cent. of cobalt.

M. Guillet accompanied his paper with a number of reproductions of micro-photographs, showing the structure of the various alloys, and also gave curves of fusibility of the more important combinations.

The importance of these researches will appear when the various combinations are given practical trials in the various branches of constructive work. It is quite possible that some of the softer alloys may become available as bearing metals, while the imparting of toughness or hardness, as the case may be, will certainly become of value. If it should be found possible to produce an alloy of great strength and hardness it might be found applicable for the production of dies for stamping metal, since such dies might be cast instead of requiring the tedious and expensive processes of cutting and hardening like steel.

While the employment of the heat of burning aluminum may not prove sufficiently economical to produce these alloys on a commercial scale, it must prove useful for purposes of research, such as M. Guillet has so successfully inaugurated.

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## SMOKE AND DUST.

### SCIENTIFIC METHODS OF PURIFYING THE ATMOSPHERE OF TOWNS AND CITIES—ANALOGIES TO WATER AND SEWAGE PURIFICATION.

*Discussions at the Sanitary Congress.*

AMONG the interesting papers presented at the Manchester congress of the Sanitary Institute may be mentioned two which dealt with the important question of the purification of the atmosphere of cities and towns. One of these, by Mr. W. N. Shaw, discussed the ever present question of smoke abatement, while the other, by Sir James Crichton-Browne, M. D. dealt with the problem of dust elimination.

It is interesting to note that far greater progress has been made in the prevention of pollution to drinking water, and to the disposal of sewage, than has been effected in the purification of the air which we are compelled to breathe.

In London, at a cost to the community of £211,000 a year, or 1.38d. in the pound on rateable value, nearly a million tons of sewage are removed, day by day, from about 600,000 houses—about a ton and a half for each house, on the average. At the same time, each day in winter, each house throws into the atmosphere, on the average, perhaps, 10 tons of smoke-laden air, or a total quantity of 5 million tons of smoke-laden air for the inhabited houses of London per day, or possibly 7 million tons per day if the factories be included. The actual weight of solid soot which gives colour and body to the smoke, is a very uncertain quantity; it may, in the worst cases, amount to nearly 3 per cent. of the coal consumed, and the houses of London probably get rid of 300 tons of solid refuse every day by throwing it up the chimney. This is mixed with much larger quantities of other more or less injurious products of the combustion of coal. The whole difference between the problem of the removal of sewage and that of the removal of smoke on similar lines, lies in the comparatively trivial distinction that under the action of the mysterious force of gravity the sewage naturally goes downwards, whereas smoke goes upwards—in the first instance, at all events. If the smoke of our fires had been in the habit of falling downwards and finding a lower level we should long ago have been driven into solving the problem of its disposal, as we have been driven to deal with the disposal of sewage.

While it is possible that the smoke which is discharged from manufacturing establishments may some day be prevented by the use of central power stations, gas producers, and internal combustion motors, the problem of the smoke emitted by private dwellings demands a different treatment. Mr. Shaw considers that it would be impracticable to establish main drains or flues for the removal of the household smoke, since it would require some forty tunnels of the size of the underground railway to deal with the smoke of London in that manner.

A more feasible treatment of the question is offered in the suggestion that it might be possible to provide precipitation chambers for each block of houses, in which the smoke could be treated before the air were permitted to pass into the outer atmosphere. It is quite possible that municipal chimneys, operated in connection with precipitation chambers might afford a means of handling the question of household smoke, without in the least interfering with the use of open fires or any other method of burning bituminous coal.

The dust problem resembles that of smoke prevention in one respect, in that it relates to the purification of the air which the residents of cities and towns are compelled to breathe. The enormous increase in the number of dust particles in city air as compared with that of the open country has been made a subject of quantitative determination. Thus, on the summit of Ben Nevis the particles of dust number about 300 per cubic centimetre, while in London they are about 150,000 per cubic centimetre, and in Paris about 210,000. It is interesting to note that in some instances the air of a small village or town is as highly polluted as that of a great city, this being explained by the fact that with the increase in the size of a city, there is not only an increase in the number of particles in the air close to the ground, but also an increase in the depth of the polluted stratum of air over the city.

The sources of dust are several, some of the most injurious dusts being those emitted by manufacturing establishments. There should be no great difficulty in dealing with these, since the sources being once definitely ascertained, proper intercepting and precipitating devices might be devised and required to be used.

A large portion of the dust in the air of great cities is due to the attrition of the pavements by the hoofs of horses and by the pulverisation of horse droppings and other organic matter. Much of this might be avoided by the use of smooth and hard pavements, and there is no doubt that the use of sheet asphalt, frequently washed and kept clean, would result in a reduction in the proportion of dust produced. Ultimately we may hope for the metallic pavement of steel, practically dustless, and free from appreciable wear.

The general introduction of motor vehicles, and the entire banishment of the horse to the country, should do much to remove from the atmosphere of the great city its most prevalent source of pollution, and this alone should form a sufficient reason for the encouragement of automobile vehicles of every description. In those cities in which electric traction has replaced horse-drawn tram cars, the improvement in cleanliness is most noticeable, and similar results would follow the removal of other sources of animal filth.

It is most encouraging to observe the question of pure air treated in a scientific manner and not second to that already applied to water and sewage disposal, and there is every reason to believe that the good work of the Sanitary Institute will do much to bring this important subject to a position which its nature demands.

# THE TECHNOLOGY OF ILLUMINATION.

FROM PRIMITIVE TORCH TO ELECTRIC ARC AND INCANDESCENT VAPOUR. A HISTORICAL AND TECHNICAL STUDY.

*Otto Lummer, before the Elektrotechnische Verein.*

WE have become so accustomed to the brilliant and effective illumination which is found in modern buildings and public places that the rapid development in the art of artificial lighting is sometimes overlooked, and hence the address recently delivered before the Elektrotechnische Verein in Berlin by Herr Otto Lummer, and published in the *Elektrotechnische Zeitschrift* will be found of interest.

Historically, the study of illuminating devices is a most attractive subject, but its thorough investigation would take more space than could be given within the limits of a treatise. Naturally the first idea of artificial lighting came with the possession of fire, and hence a blazing brand from the fire led to the use of a torch. The search for light-emitting combustibles naturally revealed the illuminating power of oils, and with this development progress was arrested throughout mediaeval times. The great palaces of antiquity were brilliantly lighted by enormous oil lamps, differing in size only from the rag floating on a chip in a dish of melted fat, even yet in common use in Italy and other parts of southern Europe; while the candle is but a more portable form of the oil lamp, with reminiscences of the primitive torch.

At the beginning of the nineteenth century only did further progress appear with the introduction of gas lighting, and this in turn remained without much improvement for three-quarters of a century, when the competition of electric lighting entered the field.

Since then progress has been more rapid. The pressure of the competition from the electric light led to the introduction of the incandescent mantle of Auer von Welsbach, opening up a fertile field which is not yet exhausted. The arc lamp was closely followed by the incandescent filament in an exhausted bulb, and this by the enclosed arc and the Nernst glower, and to-day gas and electricity vie with each other in brilliancy and in efforts for improvement. Acetylene must be reckoned as an element in the future of illumination, and there are other gases which may yet be impressed into the service of man in his desire to turn night into day.

After a rapid resume of methods of photometry and the comparison of the relative efficiency and cost of various methods of illumination, Herr Lummer proceeds to examine the physical conditions upon which the various sources of light depend. Leaving for the present, the efforts which have been made to realize the ideal of "cold light," Herr Lummer proceeds to discuss the principles of existing methods of illumination, based upon the raising of solid materials to incandescence by heat. Existing methods of illumination involve the production and emission of a large proportion of invisible heat rays which must be surpassed in order that the far greater frequency of luminous vibrations may be attained.

The study of illumination, therefore, involves an examination into the question of the production of extremely high temperatures, as well as the relation of temperature to luminosity. The luminous effect produced by high temperatures depends upon two factors: the nature of the luminous solid, and the temperature to which it can be raised. The luminous effect is greater the higher the incandescent temperature of the solid, while the greatest efficiency is obtained, the temperatures being equal, for the substances which emit the greatest proportion of visible to invisible rays. The whole subject is one involving oxidation, and while oxidation and luminosity may occur at low temperatures, as, for example, in the luminosity of phosphorus, in nearly all cases the rapid oxidation required for high luminosity can be attained only in connection with high temperatures.

Nearly all open flame lights involve the raising of carbon to incandescence by the heat of the flame itself. When, however, the heat is raised to a maximum the carbon is completely consumed, and it becomes necesary to provide some other solid substance to be raised to incandescence and luminosity. This leads at once to the idea of the Bunsen burner, producing a high heat by the complete combustion of the gas, and the employment of some incandescent substance, such as the oxides of thorium and other metals, as in the Welsbach mantle.

The principle of the electric light consists in the employment of the heating effect of the current upon a solid substance exposed to the high temperature. In the arc light the solid substance is found in the carbon points between which the arc is produced; in the incandescent lamp it is the carbon filament, the resistance of which produces sufficient heat to produce the temperature necessary for incandescence. In the more recent Nernst lamp the incandescent "glower" is composed of a non-combustible pencil of oxides, which although a non-conductor while cold, becomes of sufficient conductivity when heated to permit the passage of the electric current, while the resistance produces enough heat to maintain the temperature of incandescence. The osmium electric lamp designed by Auer von Welsbach, employs as an incandescent material the very fusible metal osmium, enclosed in a vacuum. The latest example of electric lighting is found in the mercury vapor lamp of Mr. Cooper Hewitt, in which the vapor of mercury in an exhausted tube is the incandescent substance.

In discussing all these methods of producing artificial light Herr Lummer takes up Kirchhoff's laws of the absorption and emission of light, and examines the emission of luminous and non-luminous rays.

By studying the relative emission of energy in various portions of the spectrum, he shows that the principle involved in luminosity depends upon the capacity of the luminous substance to receive all luminous rays and to reject, either by reflection or transmission, all non-luminous or heating rays. From these investigations he proceeds to discuss the laws of Stefan and Boltzmann concerning the relation of temperature to wave-length, showing that the product of the absolute temperature and the wave length is constant for the maximum production of energy, and that the maximum energy is proportional to the fifth power of the absolute temperature. He includes in the discussion a computation of the probable temperature of the sun, based upon photometric measurements, and concludes with a bibliography of articles and papers upon the modern theory of illumination.

The whole paper is an excellent resumé of the very latest information upon the production of light according to modern theories and it demands careful reading by all who are interested in this most important department of practical science.

## THE LARGE GAS ENGINE.

RAPID DEVELOPMENTS IN THE CONSTRUCTION OF LARGE INTERNAL COMBUSTION ENGINES FOR GASEOUS FUEL.

*H. A. Humphrey before the British Association.*

AT the Paris exposition of 1900 the 600 horse-power Simplex gas engine exhibited by the Cockerill company attracted more attention than any one mechanical exhibit on the grounds. Before the close of the exposition it bore a large placard relating the number of orders which had been booked, and now engines of the same size and larger are made by several builders in Europe and America.

At the Belfast meeting of the British Association Mr. H. A. Humphrey presented a paper upon recent progress in large gas engines, giving some interesting data concerning recent gas engines of 200 horse power and over, and the record is both remarkable and significant. The limiting size has rapidly grown during the past two years as is shown by the fact that Messrs. Cockerill are now constructing an engine of 2,500 horse power, and are prepared to build a 5,000 horse power gas engine.

The development of the large gas engine is closely connected with the evolution of fuel gas processes, and it is noteworthy that the first gas engines in England above 400 horse power were operated with Mond gas, while most of the large engines on the continent have been built for use with blast furnace gas.

In August, 1902, the two leading English manufacturers had delivered or had under construction 51 gas engines, varying in size between 200 and 1,000 horse-power. Of these Messrs. Crossley Brothers, of Manchester, supply 28 engines, having an aggregate of 8,300 horse-power, or an average of 296 horse-power per engine, and the Premier Gas Engine Company, of Sandiacre, Nottingham, supply 23 engines, with a total of 9,300 horse-power, giving an average of 404 horse-power per engine. These two makers collectively supply 17,600 horse-power, and of this power 12,500 horse-power is for driving dynamos.

This is a striking proof of rapid progress, but we have to look abroad for the great achievements in this direction. Neglecting all engines below 200 horse-power, we find that Messrs Körting Brothers and their licencees have made, or have under construction, 32 gas engines, with a total of 44,500 horse-power, averaging 1,390 horse-power per engine. The Société Anonyme John Cockerill, of Seraing, and their licencees come next with 59 engines, having an aggregate of 32,950 horse-power, so that the average size of the engines built by this firm is 558 horse-power. The Gazmotoren Fabrik Deutz takes the third place with 51 engines, developing collectively 20,655 horse-power, and are followed by the Deutsche Kraftgas Gesellschaft and licencees working under the Oechelhauser patents, with engines numbering 28 and giving 16,900 horse-power A classified list of these and other large gas engines shows the remarkable total of 327 gas engines, capable of supplying 181,605 horse-power.

Although America has lagged somewhat behind the Continent in adopting large gas engines, there is evidence that this state of affairs will not long remain. The De la Vergne Refrigerating Machine Company, New York, have taken out a license to manufacture the Körting engine, and have an order for sixteen 2,000 brake horse-power engines (total 32,000 horse-power) of the Körting type; and the Lackawanna Steel Works have ordered five 1,000 brake horse-power engines for coupling to dynamos. It is only a question of time before America will be one of the largest producers of gas engines, and one enterprising American firm, the Snow Steam-Pump Works, of Buffalo, New York, have already put to successful work six 1,000 horse-power gas engines, and have now nearly completed the construction of two enormous gas engine gas-compressors of 4,000 horse-power each, the first to be running by next November and the second by January, 1903. The Westinghouse Machine and Manufacturing Company, of East Pittsburg, have made gas engines of 1,500 horse-power, and are prepared to build sizes up to 3,000 horse-power.

The general details of the large gas engines at present manufactured do not differ very materially from the smaller engines of the same makers, except in minor details incident to the increased size. The Beau de Rochas cycle maintains its hold as the simplest arrangement possible, and various combinations of several cylinders are made to obtain a greater number of impulses for each revolution of the crank shaft.

The uses to which these large engines are put are about equally divided between the operation of blowing engines for blast furnaces, and for the driving of dynamos for general power distribution, the tabulated list compiled by Mr. Humphrey for engines of more than 200 horse power, completed or in hand, showing about 99,000 horse power for driving dynamos, for light and power, and 82,650 horse power for other purposes.

The demand for internal combustion motors is doubtless a result of the general demonstration of the great economy which is obtained over the steam engine. This is due, not only to the superior thermal efficiency of the gas engine itself, but also to the fact that the gaseous fuel can be supplied from a number of sources not so available for steam making. Thus the waste gases from blast furnaces have long been burned under batteries of boilers for the supply of power for blowing and other purposes, but the use of the gas engine enables the gas to be converted into power direct, without the intervention of the boilers, while the superior economy leaves a large margin of power available for other purposes.

Producer gas can be made from fuels altogether unsuited for steaming, while the by-product processes still further diminish the cost of power and add to the advantages of gaseous over solid fuel.

# ELECTRICITY IN IRON MAKING.

## FUSION OF MAGNETICALLY CONCENTRATED ORES IN THE ELECTRIC FURNACE—A SUBSTITUTE FOR BRIQUETTING.

*American Electrochemical Society.*

IN preparing magnetic ores for the furnace by the use of the various magnetic concentrators, the resulting product is in the form of a fine powder, altogether unfit for direct use in the blast furnace. For this reason it has been attempted to compress the concentrate into briquettes of sufficient size and firmness to stand the burden of the blast furnace as well as the action of handling and shipment, and while some briquetting plants have given satisfactory results there is yet much to be desired in the methods of handling and working such ores.

At the recent convention of the American Electrochemical Society a paper was presented by Mr. Marcus Ruthenberg, discussing the application of the electric current to the preparation of magnetic concentrates, and the process is of sufficient interest to warrant discussion.

The low grade magnetites are first concentrated in some form of magnetic apparatus, of which there are several in successful use, after which the concentrates are cleaned up to the highest point of purity and then put through an electrical furnace, the melting zone of which is a magnetic field.

The ore being magnetic, the magnetic field grabs and holds the grains of magnetite, and the polar projection of this magnetic field being at the same time the electrodes of the smelting circuit, the magnetic bridge thus formed by the ore forms a high resistance in the smelting circuit. The heat of the smelting circuit, therefore, is engendered within this bridge of ore itself. The electrodes are water cooled and play no part in the melting other than to conduct the current to the ore. The moment that the ore melts it loses its magnetism, and gathering weight from new molten material being added to it it falls out of the magnetic field, its place being taken by fresh portions of ore from above. The result of this operation is agglomerated, coherent masses, ranging in size from a bean to a walnut, that are hard, strong, tough and porous, differing in analysis in no way from the ore, prior to its agglomeration except for the absence of moisture and the last traces of sulphur. The product is an ideal condition for use in the blast furnace.

In the above operation the only function played by the elctric furnace is that of fusing and agglomerating the ore, there being no reduction or other separation of metallic iron. If, however, a reducing material, such as powdered cokedust or charcoal dust be added to the charge before its introduction into the electric furnace, a partial reduction takes place, the fritted mass of carbonaceous dust and iron ore, partially melted, being permitted to drop into a soaking pit.

If allowed to remain in this soaking pit a proper length of time cementation takes place through the action of the heat left in the ore by the electric furnace, and the action of the carbon fritted into the mass, which results in producing reduced metal, which may be termed steel. Any slag forming material remaining in the ore through imperfect magnetic concentration remains with the metal. These materials in any event are comparatively small in quantity, and are just what is wanted to protect the bath of molten metal in the open hearth from the scorifying effect of the furnace. This material from the soaking pits is well adapted for melting in the open hearth furnace. It thus becomes possible to produce steel direct from the ore through the intermediary of the electric furnace and the soaking pits in the form of spongy iron or steel ready for immediate melting in the open hearth without the intervention of the blast furnace in any part. The blast furnace, while well recognized as an economical machine, is essentially a concentrator, eliminating the gangue of the ore, the limestone and the ash of the coke as a cinder or slag. It costs far less to grind and magnectically concentrate for the removal of the gangue. The blast furnace also has the disadvantage of driving whatever phosphorus there may be in the ore into the resultant pig iron. The removal from the ore of this metal by magnetic concentration is a decided advantage over the blast furnace. It may be as well also to remember the fact that the limestone and fuel charge are never entirely free from sulphur and phosphorus, which in the action of the furnace are driven into the resultant pig iron, the phosphorus entirely and the sulphur partially. In the electric reduction limestone is practically absent, fuel in contact with the charge is lacking, and reducing material necessary for the elimination of the oxygen of the ore is small in quantity and may therefore be selected of exceptional purity without regard to its enhanced cost. Anything that will burn may be used for fuel to generate the electric current, which is the source of heat to be utilized in the reducing and melting of your ore. If water powers of magnitude be available they are sources of energy convertible into heat units not to be ignored.

The principal question concerning any such process as this lies in the commercial features. Heretofore all attempts to use electricity for the smelting of iron have been based on the complete fusion of the iron, and it has been computed that this would require theoretically from 3,000 to 3,500 kilowatt hours. The fritting operation described by Mr. Ruthenberg, however, requires much less energy, his experiments indicating that it may be effected with an expenditure of less than 500 kilowatt hours of electric energy.

Apart from the cost of power involved the question to be considered is the competition of cheap high-grade iron ores. The mining and handling of a low grade ore, containing from 5 to 10 per cent. of iron, must act to its disadvantage as compared with a 60 per cent. ore, so that there are other elements of cost to be considered besides those of the final treatment. It is possible, however, that for special purposes the electric process may be found advantageous, and ultimately the exhaustion of the available beds of high grade ore will render such concentration processes necessary.

In any event the practical use of the electric furnace for commercial smelting of metals will doubtless be advanced by just such experiments as Mr. Ruthenberg is making, and the information thus obtained will lead to further developments.

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# MECHANICAL AIDS TO COST-KEEPING

## APPLIANCES AND METHODS FOR OBTAINING RECORDING ORIGINAL COST DATA IN THE WORKSHOP.

*Discussion of the North-East Coast Institution.*

THE papers presented before the North-East Coast Institution of Engineers and Shipbuilders upon various details of cost-keeping and factory accounting have attracted valuable and interesting discussions, and in the recent issue of the *Transactions* the points elicited by the papers by Mr. George Parker, and by Mr. R. P. Link, upon the methods of originating the data upon which costs are based are especially interesting.

There is no doubt that the obtaining of correct and reliable original data stands at the very foundation of any system of factory accounting, and all works managers are now practically agreed in believing that the distribution of the men's time should not be originally made by the men themselves. This being assumed, it follows that the labour of collecting the data by clerks sent through the works should be diminished as much as possible by mechanical and other devices which experience has shown to be satisfactory.

Mechanical time recorders, originally devised for keeping an indisputable record of the time of arriving and leaving the works, have now become so differentiated that they may be used in every department of the establishment, and enable divisions and subdivisions of time to be recorded with convenience and accuracy.

Apart from the use of machines for the actual recording of time, they are best employed in connection with the card system of accounting, which is steadily making its way, not only in America and Germany, but also in Great Britain, where there has been more conservatism to overcome. The British accountant especially appears to be reluctant to depart from the time honoured system of books, and is disposed to mistrust the idea of cards and especially of order forms which are to accompany the work through the shop for record and entry. It is curious to observe that one of the objections which is strongly urged against the job ticket in the shop is the fact that it would become so dirty and defaced that it would be illegible by the time it returned to the office. So far from being an objection to the job order card this might better be construed as a criticism of the shops in which cleanliness is such a stranger.

As an example of the conservatism which often impedes the introduction of the systems which have been found so successful elsewhere, may be noted the very general disposition of works managers and even owners to place themselves almost invariably on the defensive, and to take the position that anything other than that to which they have become accustomed is to be opposed and criticised adversely.

The rational position to take is that of a searcher after the truth, ready to consider in a manner apart from any local or national prejudice whatever will aid in the determination of the real facts which exist in connection with the work of the establishment. The all important thing is to determine as closely as possible just exactly what takes place in connection with the passage of a piece of work through the shop. Certain things about it are true; others are only approximately so; and still others are altogether doubtful, but the truth can be had, and anything which aids in this good work should be encouraged, no matter whose prejudices are antagonized. As a matter of fact, there is no real difficulty about the determination of the entire history of every piece of work which passes through the works, if only the subject be considered as a succession of perfectly intelligible operations. Usually this can be done on a time basis, but if the development of the establishment has progressed far enough in the scale of workshop evolution, the labour cost of most of the operations will be determined upon the piece basis, in which case the question becomes mostly a matter of counting, eminently adapted for mechanical treatment.

Cost records should be made, not only for the purpose of determining minimum selling prices, but also with the object of discovering opportunities for economy. It is not enough to know how much a machine costs to manufacture, it is most essential that the manager should know why it costs as much as it does, and if the next machine or other article costs more or less than it did the last time it was made, the records should enable the portion of the work in which the difference exists to be promptly and accurately discovered. Indeed this is the most important element in a really truthful system of cost keeping. A method may give most beautifully precise results, in so far as showing a correct balance between distributed costs and wages totals are concerned, and yet be so inaccurate as to be wholly misleading to any one who might attempt to draw useful conclusions from it. If the one great object of the ascertainment of the exact truth about the methods and conditions of the conduct of the establishment be made the criterion by which a cost system be judged, the atmosphere would be greatly cleared from much of the fog which now obscures it.

The treatment of establishment charges is one which is often considered in a deceptive manner. Some managers appear to feel that establishment charges are in themselves something discreditable, and that if they can be so apportioned amongst the various machine operations as to be concealed as expense charges, they are no longer objectionable. A really truthful system of cost keeping permits nothing to be charged directly to a piece of work but that which it has really and definitely caused, and if establishment charges are to be rationally reduced it can only be by their being really understood. The same is true of depreciation charges, and the fact that a tool still stands on the inventory at a positive value does not at all prevent it from being a venerable candidate for the scrap heap.

The most important thing about the whole business is for owners and works managers to abandon the ostrich-like tendency to bury their heads in the sand and believe that they can avoid the detection which is in many instances awaiting them in the form of ruinous competition from rival establishments whose only strength lies in the fact that they know exactly what they are doing and why they are doing it.

# THE BEAUMONT OIL FIELD.

## GEOLOGICAL AND INDUSTRIAL CONDITIONS ACCOMPANYING THE DEVELOPMENT OF THE OIL FIELDS OF THE TEXAS REGION.

*American Institute of Mining Engineers.*

SO much has been published about the oil fields of Texas which bears the evident impress of the promoter, that it is most satisfactory to receive the scientific paper of Mr. Robert T. Hill, contributed to the *Transactions* of the American Society of Mining Engineers, giving a reliable account of the whole region.

Mr. Hill discusses at length the sedimentary rocks of the Texas oil region connected with the oil problem, showing that they are by no means all of the same geological period, all however belonging to the Cretaceous and later ages. The first well, bored by Captain Lucas, passed through 1,100 feet of clay and quicksand, and the oil when struck had a temperature of more than 110°F.

Since the beginning of 1901, when the first gushing well was struck, the production has increased until it is estimated that the output for 1902 will reach 20,000,000 barrels.

The location of the fields is an important factor in their commercial development. Three pipe lines have been finished, two to Port Arthur, 19 miles long, and one to Sabine, 24 miles long. Other lines are planned, so that there will be no difficulty in delivering the oil to seaports, independently of any railway complications. At the same time there are extensive railway facilities, and the transport problem is one which requires only sufficient time to be solved in more ways than one.

The applications of the oil are well described by Mr. Hill:

"Within a year from its discovery, Beaumont oil is burning in Germany, England, Cuba, Mexico, New York and Philadelphia. By its energy steamers are being propelled across the ocean, trains are hastening cross the continent, electricity generated and artificial ice frozen in New York, ores ground and stamped in Mexico, Portland cement manufactured in Havana and Texas, and gas enriched in Philadelphia; and this, too, while half the world is either unaware or incredulous of the value of this fuel."

The occurrence of the oil with much sulphur, sulphuretted hydrogen, and salt has complicated the theories of its origin, and as yet no altogether satisfactory hypothesis has been offered. Mr. Hill, however, taking the experimental data collected by Captain Lucas, offers a theory which he sets forth as follows:

"The hypothesis is offered with hesitation, not as a final explanation, but in the hope that it may serve as a basis for discussing through which the truth may be reached. I think it fully interprets the Lucas group of phenomena, and accounts for the mystery of Spindle Top far more satisfactorily than any other thus far presented; and that it may also account for the independent origin of the sulphur, sulphuretted hydrogen and gypsum, regardless of their association with the oil.

The hypothesis is as follows: The oil- and salt-pockets of the Texas Coastal Plain are probably not indigenous to the strata in which they are found, but are the resultant products of columns of hot saline waters which have ascended, under hydrostatic pressure, at points along lines of structural weakness, through thousands of feet of shale, sand, and marine littoral sediments of the Coastal Plain section, through which oil and sand are disseminated in more or less minute quantities. The oil, with sulphur, may have been floated upward on these waters, and the salt and dolomite may have been crystallized from the saturated solution.

"The channels of these ascending waters may have been in places of structural weakness, such as fissures, which probably at one time continued to the surface, but may have been sealed by the deposition of the later overlapping strata now capping the oil-pools. Such features, when occurring under gentle anticlines, may explain the collection of oil beneath the surface in pools."

The importance of the experience which is being gained with the Texas fuel oil comes with especial force and value in the light of the effect of the strike in the anthracite coal regions of Pennsylvania. The greater the number of fuel resources, the less the probability of a deficiency in the supply at any one time. It is altogether possible that those establishments which must be independent of artificial restrictions in the supply of fuel will hereafter equip themselves for oil fuel as well as coal, and use whichever is most available, the possibilities of a stoppage being far more remote in such circumstances. For marine purposes it is possible that oil fuel may solve the problem of the stoking of boilers mechanically at sea, and thus remove the difficult question of hand stoking, with all its labor troubles.

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# THE HEAT TREATMENT OF STEEL.

### OVERHEATING AND ANNEALING—POPULAR FALLACIES CONCERNING THE BEHAVIOUR OF STEEL UNDER HEAT CONTROVERTED.

*Prof. Heyn, before the Iron and Steel Institute.*

IT is a rather interesting fact that whenever any one comes out with some startling proposition concerning principles which it is supposed were definitely settled, various people rise up at once to say that they knew it all long ago. Thus it has been generally accepted that steel was made tough by heating it to a full red and allowing it to cool very slowly. The high heat was considered to be best applied for several hours, and the cooling prolonged through several days. Now, in his paper presented before the Iron and Steel Institute at Düsseldorf, Professor Heyn, of Charlottenburg, says that when low-carbon mild steel is annealed at temperatures above 1,000 degrees C. there occurs an increase in brittleness if the annealing period is sufficiently long. This action Professor Heyn calls "overheating," and he takes care to distinguish carefully between this and what is called "burning." Overheating is distinctly limited to include changes, due to heat, of a purely physical character, unaccompanied by any chemical change, while burning conveys the idea of a process of combustion, the taking up of oxygen by the metal, involving a chemical change.

The general phenomena observed by Professor Heyn may be summed up as follows:

If it is attempted to anneal steel at a temperature above 1,000° C., the brittleness increases, growing with the increase in temperature and with the duration of the process. For temperatures between 700° and 890°, no increase in brittleness is produced, however prolonged the annealing. It is, therefore, possible so to regulate the temperature and time to produce any desired degree of brittleness. The temperature at which the brittleness increases with time lies somewhere between 900° and 1,100°. The effects of overheating do not require the extreme white heat for their production, appearing at considerably lower temperatures, it being only necessary to give sufficient time to produce the most marked effects.

As a result of these facts, the process of annealing, to be effective, must be carried out with certain precautions. Taking a temperature of 900° C., which should not be greatly exceeded, a short period, say about half an hour, is sufficient, and in fact, longer annealing should be carefully avoided; and the nearer the temperature limit of about 1,000° C. is approached, the shorter should be the time during which it is maintained. It is important, however, that the temperature should be at least 900° C., since below that heat an annealing of several hours is not sufficient to remove brittleness, although the desired result can be attained by annealing at a temperature between 700° and 850° for several days.

The discussion of the paper brought some experiences of other observers which fully confirm and supplement Professor Heyn's researches. Thus Mr. Stead stated that while steel could be made tough by heating it to temperatures under 1,000° C., it would be made brittle by raising it to 1,200°. A short heating to a high temperature of a brittle steel with a coarse grain, will produce a fine grain, while the same result will be obtained by a longer heating at a lower temperature.

Another element to be taken into consideration is the size of the piece under treatment, since time is required for the rearrangement of the particles to take place.

The most important fact of the whole subjeit is that brittleness can be entirely removed by raising the steel to the proper temperature for but a single minute and then permitting it to cool in the air at once. It can be made entirely a matter of temperature but the temperature must be just right; if too low, the brittleness will not be removed, if too high, overheating will occur.

The importance of this fact in practical work cannot be overestimated. Failure in structural work doubtless arises often from brittleness in the material, a defect not revealed by chemical analysis nor by the usual tensile tests. If, however, freedom from brittleness can be entirely assured by such a methodical operation and rapid heating and immediate cooling, the only essential being the strict maintenance of the proper temperature, there is no permissible reason for the use of any brittle material in a steel structure. As Mr. Stead put it: If, in the future, lives are lost by the failure of a properly designed steel structure, those who have neglected the reheating process should be held guilty of manslaughter.

## THE AMERICAN ELECTROCHEMICAL SOCIETY.

### RAPID DEVELOPMENT OF AN ORGANIZATION REPRESENTING A NEWLY CREATED DEPARTMENT OF INDUSTRY.

*Convention at Niagara Falls.*

It has been observed that in some respects the science of electrical engineering is becoming more and more a department of mechanical engineering, the great power stations and applications containing much more mechanical than electrical work, but this cannot be said of the recently developed and rapidly growing electrochemical industries. The mere fact that this department of applied science has become of sufficient magnitude to maintain a large and prosperous professional society is evidence of its prominence and activity.

It is interesting to note that the real development of modern chemistry owes much of its progress to the electrochemical researches of Davy and of Faraday, but it was not until the arrival of the dynamo and hydroelectric station, providing an ample supply of cheap electrical energy, that it became possible to turn the tables and enlist electricity as an effective agent in the industries of manufacturing chemistry. Now that this has been done, however, the art has progressed so rapidly that the older methods of chemical manufacture are constantly undergoing revision, while new products, hitherto not produced artificially, have been added to the list of marketable supplies.

Niagara Falls is an especially appropriate situation for a meeting of electrochemists, since it is there that the greatest installations of electrical manufacturing of chemical products are operated. It is only necessary to mention the subjects of aluminum, carborundum, artificial graphite, calcium carbide, caustic alkalies, artificial nitric acid, etc., etc., to show to how great an extent the electrochemical industries have been dependent upon the great power plants at Niagara Falls for their existence.

It is unfortunate, however, that the policy of secrecy and isolation which has distinguished the electrochemical industries at Niagara Falls should have been maintained during the convention of men best qualified to appreciate them. It has been the experience of all other technical societies that the open handed hospitality of all the establishments in their especial lines has been of great value to the hosts as well as to the visitors. The men who welcome all visitors to their works make no mistake in so doing, they might, if it were necessary, plead selfishness as a reason for their open doors, since they may learn more than they teach. In other departments of engineering it is well appreciated that the days of old-time secretiveness are past, and that a man who has to conduct his work behind closed doors is not likely to keep up in the van of the procession. Doubtless as the managers of the electrochemical industries become interested in the work of the society they will learn to abandon their present unfortunate attitude, and realize that they have as much, if not more to learn than they have to show.

# THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages from a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

*We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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## CIVIL ENGINEERING

### BRIDGES.

**Arches.**

Heavy Concrete Arches. Describes a double 50-foot concrete arch bridge, having a greater thickness of arch width than is ordinarily used. 1000 w. Eng Rec—Aug. 30, 1902. No. 50314.

The Computation of Circular Arched Girders (Beitrag zur Berechungsweise der Kreisbogenträger). Adolf Francke. With formulas and diagrams for the determination of stresses in circular braced arches with joints at various points. 3000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 23, 1902. No. 50744 B.

The Proper Curvature for a Filled Arch. Daniel B. Luten. Discusses points in the construction and design. 2000 w. R R Gaz—Sept. 12, 1902. No. 50517.

**Bridge Terminal.**

A Proposed New Brooklyn Bridge Trolley Terminal Plan. A brief illustrated explanation of the plan designed by Mr. Neils Poulson. 500 w. Eng News—Sept. 11, 1902. No. 50507.

**Brooklyn Bridge.**

Plan for Relieving Brooklyn Bridge. Illustrations and plans with description of changes proposed by Neils Poulson, for relief of the congestion of traffic at the

Manhattan terminal. 900 w. St Ry Jour —Sept. 20, 1902. No. 50660 D.

**East River Bridge.**

The Footbridge for Building the Cables of the New East River Bridge, New York. Isaac Harby. Gives a brief description of the cables and a statement of the conditions encountered, with an illustrated description of the construction of the foot bridge, giving the reasons for constructing it. 6300 w. Pro Am Soc of Civ Engrs—Sept., 1902—No. 50686 E.

**Fraser River.**

A New Bridge Over the Fraser River at New Westminster, British Columbia. An illustrated detailed description of a bridge having two decks, one for wagon traffic and the other for steam and electric railroad traffic. 1700 w. R R Gaz—Aug. 29, 1902. No. 50270.

**North Wales.**

Bridge Over Llyfni. Illustrates and describes a bridge of rather unusual construction recently erected by the owners of the South Dorothea Slate Quarry at Nantile, North Wales. 600 w. Engr, Lond—Aug. 22, 1902. No. 50365 A.

**Old Bridges.**

Unit Stresses and Impact in Old Railway Bridges. A. F. Robinson. Abstract of a lecture delivered at the Univ. of Illinois. Discussing what is the highest unit stress that may be permitted in old metal bridges, and how long the structures will be apt to last. 2000 w. Eng News—Sept. 25, 1902. No. 50676.

**Reinforced Concrete.**

Concrete-Steel Bridges. D. B. Luten. Considers the suitability of this material for bridge construction, giving illustrated descriptions of the method of design used. 1300 w. Munic Engng—Sept., 1902. No. 50329 C.

**Viaduct.**

The Eighteen Mile Creek Viaduct. Illustrated description of the method of replacing a double-track viaduct with a new structure at the same grade on the same piers, without interrupting traffic. 2300 w. Eng Rec—Sept. 20., 1902. No. 50641.

## CANALS, RIVERS AND HARBORS.

**Altona.**

The Enlargement of the Harbor of Altona (Erweiterung des Altonaer Hafens). H. v. Horn. With details of the new dyke by which the new harbor is enclosed and protected from storms and ice. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 13, 1902. No. 50746 B.

**Barge Canal.**

The New York Barge Canal Project Again. Editorial, discussing the report against the Ontario route just rendered by the committee of Canal Assn. of Greater N. Y. 1600 w. Eng News—Sept. 11, 1902. No. 50506.

**Breakwater.**

See Civil Engineering, Materials.

**Canal Haulage.**

See Electrical Engineering, Power Applications.

**Coast Protection.**

The Protection and Improvement of Foreshores by the Utilization of Tidal and Wave Action. R. G. Allanson-Winn. Discusses how to permanently safeguard a line of frontage from ,the erosive action of the sea at low cost, commending the system of groyning discovered by Edward Case. Ill. 7000 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50428 E.

The Sea Coast. A review of a recent book, by W. H. Wheeler, containing a wonderful amount of information concerning coasts, defensive works, sea walls, groynes, etc., especially as regards the coasts of England. Ill. 5400 w. Builder —Sept. 6, 1902. No. 50551 A.

**Dams.**

A Proposed New Type of Masonry Dam. Discussion of the paper by George L. Dillman. 2700 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50435 E.

A List of Failures of American Dams. W. R. Hill. An annotated list from the presidential address before the Am. W. Wks. Assn. 4400 w. Eng Rec—Sept. 27, 1902. No. 50822.

Construction of the Lauchensee Dam. Condensed from the *Zeitschrift für Bauwesen.* H. Frecht. An outline of construction methods used in a difficult and expensive masonry dam built to increase the low-water flow in the streams of the Vosges Mountains. 2700 w. Ill. Eng Rec—Aug. 30, 1902. No. 50310.

Reconstruction of the Lake Winnibigoshish Dam. Illustrated description of a movable dam having five drum gates of the Tainter type and a reversed bear-trap gate. 3200 w. Eng Rec—Sept. 13, 1902. No. 50524.

The Break in the Utica Reservoir. Illustrated description of the manner in which a 70 ft. earth dam failed. 600 w. Eng Rec—Sept. 27, 1902. No. 50821.

The San Leandro Earth Dam of the Oakland Water Works. Burr Bassell. An illustrated description of a high earth dam originally built in 1874-5, but since raised to a height of 125 ft. above the original surface, 155 ft. above the bottom of the central puddle trench, and 158 ft. above the bottom of the concrete-filled secondary trenches. A large part of the embankment was sluiced in by the hydraulic process. 1300 w. Eng News—Sept. 11, 1902. No. 50504.

**Dredging.**

Dredging Machines. John Bogart. Read before the International Nav. Cong. at Düsseldorf. Deals with the construction, capacity, and cost of operating dredging machines of several types in recent excavations of large magnitude. 5600 w. Engng—Aug. 29, 1902. No. 50473 A.

The Cost of Dredging with Different Classes of Plant. John Bogart. Condensed paper read before the International Nav. Cong. at Düsseldorf. Describes centrifugal pump, dipper and vacuum pump dredgers employed in excavating 1,500,000 cu. yds. of clay and earth, and gives itemized cost of excavation with each class. 5000 w. Eng Rec—Sept. 13, 1902. No. 50523.

**Dry Dock.**

A New Japanese Dry Dock. Illustrates and describes the Kawasaki Company's dry dock at Kobe, built wholly under the direction of native trained experts. Many difficulties were met, but the construction seems practically perfect. 2400 w. Engng—Aug. 22, 1902. No. 50369 A.

**Floating Dock.**

Durban Floating Dock. Illustrates and describes the launch of this floating dock built to the order of the Natal Government. 1000 w. Engrs' Gaz—Sept., 1902. No. 50465 A.

**Isthmian Canal.**

Sanitary Problems Connected with the Construction of the Isthmian Canal. Geo. M. Sternberg. Considers how best to avoid unnecessary sacrifice of life by those employed on this great work. 3700 w. N Am Rev—Sep., 1902. No. 50321 D.

**Locks.**

A New Canal-Lock System (Ein Neues Sparschleusen-System). Prof. L. Czischek. A description of the Tenscher-Czischek systems in which a rolling cylinder displaces the water necessary to effect the desired difference in level. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Aug. 29, 1902. No. 50729 B.

**Lighthouse.**

The Lighthouse at L'Ile Vierge. Illustrations and description of a recently completed lighthouse off the coast of Brittany, which has the distinction of being the most lofty yet erected. 2800 w. Engng—Aug. 22, 1902. No. 50368 A.

**Nile.**

The Nile Irrigation Works. An illustrated article describing the great dam at Assouan, the locks, sluices, etc. 2000 w. Sci Am—Sept. 20, 1902. No. 50601.

**Piles.**

Sinking and Testing an Iron Pile. Describes the method of sinking a pile at Hoboken, N. J., at the foot of pier C in the North River. 1600 w. Eng Rec—Aug. 30, 1902. No. 50315.

**River Improvement.**

Improvement of the Black Warrior, Warrior and Tombigbee Rivers, in Alabama. Discussion of the paper by R. C. McCalla. 7800 w. Pro Am Soc of Civ Engrs—Sept., 1902. No. 50687 E.

## CONSTRUCTION.

**American Methods.**

The American Engineer in England. William G. Sloan. Describes the work of building the plant ot the British Westinghouse Elec. & Mfg. Co., comparing English and American methods and giving many interesting facts. Ill. 5200 w. Jour W Soc of Engrs—Aug., 1902. No. 50286 D.

**Building Construction.**

The Bank of the State of New York. Illustrated description of a 25-story, steel-cage structure resting on foundation piers sunk by the pneumatic process, and showing many unusual details in the wind bracing and connections of the steel-work. 3800 w. Eng Rec—Sept. 13, 1902. No. 50521.

**Dams.**

See Civil Engineering, Canals, Rivers, and Harbors.

**Dome.**

Steel Dome for West Baden, Ind., Hotel; the Largest Dome in the World. Views, drawings and description of this great structure. 1000 w. Eng News—Sept. 4, 1902. No. 50394.

**Foundations.**

Lowering a Heavy Foundation Girder. Illustrated description of the method used in constructing the foundations of a large steel-cage, twenty-story office building in New York. 1100 w. Eng Rec—Aug. 30, 1902. No. 50318.

**Office Building.**

The Blair Building, New York. Illustrated description of the construction of a 20-story, steel-cage office building in New York. 3000 w. Eng Rec—Sept. 6, 1902. No. 50448.

**Pavements.**

See Civil Engineering, Municipal.

**Permanence.**

Relative Permanence of Steel and Masonry Construction. Informal discussion of whether steel is susceptible of being made as permanent a building material as masonry. 4000 w. Pro Am Soc of Civ Engrs—Aug, 1902. No. 50431 E.

**Roads.**

An Appreciative Analysis of Macadam Road Construction. C. H. W. Biggs. Read at the Bristol meeting of the Incor.

Assn. of Munic. & Co. Engrs. Gives the writer's views on proper construction of roads. 1300 w. Builder—Aug. 30, 1902. No. 50453 A.

Notes Concerning Road Construction. Describes the method employed in building the State aid roads in New York. Also gives the recent experience of the State roads of Massachusetts. 1800 w. Eng Rec—Aug. 30, 1902. No. 50313.

Road Grades. C. H. Fitch. A discussion of some points in road surveying and construction. 1400 w. Min & Sci Pr—Sept. 6, 1902. No. 50494.

The Adjustment of Macadam Road Design to Various Subgrade Soils. From the report of the Massachusetts Highway Commission, describing methods employed. 700 w. Eng News—Sept. 4, 1902. No. 50400.

**Skeleton Construction.**

The New York Steel Buildings. From the *Birmingham Daily Post.* Extract from an article giving a description of the latest manner of building in New York, as it appeared to an Englishman. 2500 w. Archt, Lond—Sept. 5, 1902. No. 50552 A.

The Steel Framework of the Farmers' Bank Building, Pittsburg, Pa. An illustrated description of the steel structural work of a 24-story office building. 4200 w. Eng News—Sept. 18, 1902. No. 50590.

**Tunnels.**

Difficult Work in Repairing a Swiss Railway Tunnel. Illustrates and describes methods of repairing a rock fall which was so serious that traffic was interrupted for 53 days. 900 w. Eng News—Sept. 25, 1902. No. 50675.

Difficult Work on the Meudon Tunnel on the New Railway from Paris to Versailles. Translated from *Le Génie Civil.* An illustrated description of interesting work because of the difficulties encountered. 1800 w. Eng News—Sept. 11, 1902. No. 50505.

The Simplon Tunnel (Simplon Tunnel). An abstract of the quarterly report of progress on the Simplon tunnel, showing the work and operative conditions from March to June, 1902. 2000 w. Schweiz Bauzeitung—Aug. 30, 1902. No. 50737 B.

**Underpinning.**

Complicated Underpinning. Illustrated description of methods of supporting high walls where the working space was unusually restricted. 2000 w. Eng Rec—Sept. 27, 1902. No. 50826.

## MATERIALS.

**Building Stone.**

The Stone Resources of Washington. The first of a series of illustrated articles giving an account of the building stones of this state, and their development. 2200 w. Stone—June, 1902. Serial. 1st part. No. 50478 C.

**Concrete.**

Materials for the Concrete of the Buffalo Breakwater. Emile Low. Illustrated article giving details of this work, which is a departure from ordinary methods as usually practiced in concrete construction. 2500 w. Eng News—Sept. 11, 1902. No. 50502.

Submarine Concrete Work at the Nussdorf Locks (Betonierungen unter Wasser bei der Schleusen-Anlage in Nussdorf). Emil Grohmann. Giving details of the apparatus for mixing and delivering the concrete to the submarine foundations. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 22, Sept. 12, 1902. No. 50730 each B.

**Reinforced Concrete.**

Concrete-Steel Theory and Computations. Editorial discussion of the experimental facts available for testing the value of formulas for the strength of concrete steel beams and posts, and of the best form of formulas for practical use. 1400 w. Eng Rec—Sept. 13, 1902. No. 50520.

See Civil Engineering, Bridges.

**Rust Prevention.**

Tests of Various Paints on the 155th St. Viaduct, New York City. Reprinted from the N. Y. *Evening Post.* A report of the second examination of the paints applied in 1897 with a view of determining their comparative protective qualities. 1000 w. Eng News—Sept. 4, 1902. No. 50397.

The Chemistry of the Protection of Steel Against Rust and Fire by Concrete. Notes supporting the evidence of the efficiency of this protection. 1700 w. Sci Am Sup—Sept. 20, 1902. No. 50602.

**Wood Preservation.**

The Rapid Ageing and Fireproofing of Wood. Translated from the *Revue de Chêmie Industrielle.* Gives a brief analysis of the principal methods which have given fairly good results, and describes the Nodon and Bretonneau process which utilizes electricity. 6300 w. Sci Am Sup—Sept. 6, 1902. No. 50405.

## MEASUREMENT.

**Base Measurement.**

Rapid Base Line Measurement for the Ninety-Eighth Meridian Triangulation. Illustrated description of methods followed by the U. S. Coast and Geodetic Survey in which steel tapes were employed in comparison with older methods. 4900 w. Eng Rec—Sept. 27, 1902. No. 50823.

The Base Line Measurements for the 98th Meridian Triangulation. John F. Hayford. Gives the principal features of this work, calling attention to departures from past practice. Of value as a record of rapid and economical measurement of bases of a primary degree of accuracy. Ill. 5400 w. Eng News—Sept. 4, 1902. No. 50396.

**Surveys.**

A brief discussion of the Law of Boundary Surveys. William E. Kern. 6000 w. Eng News—Aug. 28, 1902. No. 50267.

## MUNICIPAL.

**Contracts.**

See Civil Engineering, Miscellany.

**Garbage Destruction.**

Engineer's Report on the Garbage Furnaces of Trenton, N. J. A reprint of the report of Mr. Rudolph Hering, which is a comprehensive study of conditions at Trenton and of garbage cremation in general. 8500 w. Eng News—Sept. 11, 1902. No. 50508.

**Municipal Ownership.**

See Industrial Economy.

**Pavements.**

Pavements in General. Charles E. P. Babcock. Notes concerning asphalt pavements principally. 3500 w. Jour Assn of Engng Socs—Aug., 1902. No. 50694 C.

Paving a Country Road with Brick. Samuel Huston. Slightly condensed from a paper read before the Ohio Soc. of Civ. Engrs. & Surv. A statement of the conditions where the road is located with a description of the construction. 1700 w. Eng News—Sept. 25, 1902. No. 50673.

Street Paving. B. F. Fendall. Read at meeting of the League of Am. Munic. Gives the experience in Baltimore. Recommends bituminous pavements, and suggests a combine of cities to reduce the price of asphalt. Ill. 2200 w. Munic Jour & Engr —Sept., 1902. No. 50291 C.

**Roads.**

See Civil Engineering, Construction.

**Sewage Disposal.**

Sewage Purification Experiments at York, England. A review of the report of Mr. Alfred Creer, concerning careful investigations made. 3300 w. Eng Rec—Sept. 6, 1902. No. 50446.

The Bacterial Treatment of Trades Waste. William Naylor. Abstract of a paper read before the Inst. of Civ. Engrs. Describes experiments at bleaching works, print works, breweries and dye works. 4000 w. Eng Rec—Sept. 20, 1902. No. 50644.

**Sewers.**

A 27 and 30-inch Concrete Sewer. Illustrated description of the methods of construction of an unusual type of stormwater sewer recently completed at Truro, Nova Scotia. 1500 w. Eng Rec—Aug. 30, 1902. No. 50311.

## WATER SUPPLY.

**Artesian Wells.**

An Engineering Commission on the Artesian Wells of the Memphis Water Works. A recent study of this system which forms a part of a report of a commission of engineers appointed by the city authorities to report on the "condition and value" of the works. 6100 w. Eng News —Sept. 25, 1902. No. 50677.

The Kasusa System of Artesian Well Boring in Japan. Describes method used to bore wells of great depth. 1200 w. Eng News—Sept. 4, 1902. No. 50938.

**Ground Water.**

Underground Water. Editorial discussion of a case recently brought before the English courts. 1500 w. Engng—Aug. 22, 1902. No. 50373 A.

**Irrigation.**

Notes on Irrigation Engineering. Extracts from testimony by Elwood Mead before the U. S. Industrial Commission, on the losses of water by seepage from canals, the filling of canals by silt, and the filling of reservoirs by silt. 2700 w. Eng Rec—Sept. 20, 1902. No. 50643.

See Industrial Economics.

**Organisms.**

Crenothrix as a Source of Trouble in Public Water Supplies. Extracts from a paper by Daniel D. Jackson, printed in *The Journal of the Society of Chemical Industry*, on "The Precipitation of Iron, Manganese and Aluminum by Bacterial Action." 800 w. Eng News—Sept. 4, 1902. No. 50402.

**Ozone.**

The Purification of Drinking Water by Ozone (Die Reinigung des Trinkwassers durch Ozon). Dr. H. J. van't Hoff. A review of the methods thus far applied, with tabulated data and results of tests in Holland, Belgium, France, and Germany. 1500 w. Zeitschr f Elektrochemie—July 24, 1902. No. 50768 G.

**Pipe.**

Standard Specifications for Cast-Iron Pipe. Gives specifications adopted by the New England Water Works Assn., with notes on their special features. 2200 w. Eng Rec—Sept. 13, 1902. No. 50522.

**Rates.**

"Fair, Just and Reasonable Water Rates." A discussion from the point of view of a private company, of certain factors to be considered in determining rates. 2500 w. Eng Rec—Sept. 20, 1902. No. 50642.

**Reservoirs.**

A New Covered Reservoir at Newton, Mass. Describes especially the covering, which is of flat concrete steel construction.

Ill. 1200 w. Eng Rec—Aug. 30, 1902. No. 50312.

The Construction of a Reservoir and Standpipe on Forbes Hill, Quincy, Mass. C. M. Saville. An illustrated detailed account of the construction work, cost, etc. 14800 w. Jour N E W Wks Assn —Sept., 1902. No. 50438 F.

**Rural Supplies.**

Rural Water Supplies. James Dewhirst and Horace G. Keywood. Read at Leicester meeting of the Brit. Assn. of W. Wks. Engrs. Chief points of the paper and discussion. An account of what has been done in the Maldon and Chelmsford districts. 5500 w. Jour Gas Lgt—Aug. 16, 1902. No. 50357 A.

**Statistics.**

Water Works Statistics for the Year 1901, in Form Adopted by the New England Water Works Association. Compiled by Charles W. Sherman. Tabular report of pumping statistics, financial statistics, consumption, distribution, etc. 1500 w. Jour N E W Wks Assn—Sept., 1902. No. 50439 F.

**Water Rights.**

A Complication of Water Rights. Condensation of the opinion rendered in a case in Utah, which is of interest to hydraulic engineers and managers of water works. 3500 w. Eng Rec—Aug. 30, 1902. No. 50320.

**Water Works.**

An Unusual Water Supply Plant. Describes works at Arad, Hungary, having air lifts and Fischer filters. 1200 w. Eng Rec—Sept. 27, 1902. No. 50824.

**Wisconsin, U. S. A.**

Wisconsin Water Supplies. W. G. Kirchoffer. Gives the history, sources of supply, quality and treatment of waters, population supplied, etc. 3800 w. Municipality—Sept., 1902. No. 50426.

### MISCELLANY.

**Contracts.**

Municipal Contract System. Thomas G. Hayes. Read before the League of Am. Munic. Describes the Baltimore system and gives reasons for favoring the method adopted. 1500 w. Munic Jour & Engr—Sept., 1902. No. 50292 C.

Unreasonable Contract Requirements by the Government. A discussion of the futility and unreasonableness of specifications forcing all the risk of a difficult work on the contractor without giving him reasonable compensation. 1700 w. Eng Rec—Sept. 20, 1902. No. 50640.

**Engineering Ethics.**

The Regulation of Engineering Practice by a Code of Ethics. Informal discussion of whether engineering practice should be so regulated, and if so, how such a code can be established. 7500 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50434 E.

**Specifications.**

An instructive Study of Specifications. Extracts from a specification recently issued by the Bureau of Yards and Docks of the U. S. Navy, for the building of a masonry dry dock at Charleston, S. C., to cost about one million dollars, with comment. 3700 w. R R Gaz—Sept. 12, 1902. No. 50515.

Engineers, Contractors and Specifications. Editorial discussing the troubles arising from prevailing practice. 2500 w. Eng News—Sept. 18, 1902. No. 50589.

# ELECTRICAL ENGINEERING

### COMMUNICATION.

**Cable Relay.**

Automatic Relay Translation for Long Submarine Cables. S. G. Brown. Read before the Inst. of Elec. Engrs. Illustrates and describes a system in every day use on some of the lines of the largest cable companies. 4000 w. Sci Am Sup—Sept. 20, 1902. No. 50603.

Vibrating Cable Relay. K. Gulstad. On the working of the apparatus which has given favorable results with some of the cables of the Great Northern Telegraph Co. Ill. 1800 w. Elec Rev, Lond—Aug. 22, 1902. Serial. 1st part. No. 50350 A.

**Common Batteries.**

Common Battery Points. J. C. Kelsey. A discussion of some of the defects of common batteries for telephone systems and the means of remedying them. 2700 w. Telephony—Sept., 1902. No. 50414.

**Space Telegraphy.**

On Some Phenomena Affecting the Transmission of Electric Waves Over the Surface of the Sea and Earth. H. B. Jackson. Read before the Royal Soc. Describes results of phenomena observed during experiments, and gives conclusions drawn as to their cause. 2400 w. Elec Rev, Lond—Aug. 22, 1902. Serial. 1st part. No. 50351 A.

Telegraphy Without Wires (La Télégraphie sans Fil). G. Espitallier. A general study of the practical apparatus for the use of magnetic waves for telegraphing through space. Serial. Part I. 3000 w. Génie Civil—Sept. 6. 1902. No. 50726 D.

Wireless Telegraphy and Maxwell's Theory. Frederick K. Vreeland. On the value of Maxwell's theory in furnishing an explanation of the greater facility of transmission over water than over land, and of other perplexing problems. 2800 w. Elec Wld & Engr—Sept. 13, 1902. No. 50544.

**Telegraphy.**

The Evolution of Electrical Telegraphy. Perry F. Nursey. A brief article showing that the idea embodied in the telegraph was expressed in the writings of Galileo, Shakspeare and early writers, though not made practical until the last century. 1700 w. Elec Engr, Lond—Aug. 29, 1902. No. 50457 A.

**Telephony.**

The Designing of Telephone Apparatus. W. A. Taylor. Discussing points of importance representing the best practice. 2600 w. Elec Rev, N Y—Sept. 13, 1902. Serial. 1st part. No. 50539.

The Housing of a Telephone Plant. Herbert Laws Webb. An illustrated article tracing the evolution of the modern telephone exchange building. 4800 w. Elec Wld & Engr—Aug. 30, 1902. No. 50277.

Underground Work for Telephone Exchanges. Arthur V. Abbott. The first of a series of articles dealing with the conductive system, describing the details of the plant, calculating cost, etc. 1300 w. Elec Wld & Engr—Aug. 30, 1902. Serial. 1st part. No. 50279.

## DISTRIBUTION.

**Great Britain.**

The Electrical Power Distribution Systems of Great Britain. An outline map showing the areas and situations occupied by the respective schemes with some particulars relating to them. 1500 w. Elec Rev, Lond—Sept. 12, 1902. No. 50622 A.

**Three-Wire.**

Distribution with Uninsulated Neutral. E. Morgan. Discusses this question and its advantages, and suggests a system of distribution. 1000 w. Elec Rev, Lond—Aug. 29, 1902. No. 50462 A.

Re Earthing the Middle Wire in Three-Wire Distributing Systems. G. Hooghwinkel. Presenting the advantages of using a bare neutral wire. 1500 w. Elec Rev, Lond—Aug. 29, 1902. No. 50460 A.

**Wiring.**

Some Notes on Electric Wiring. George A. Clark. Read at Glasgow meeting of the Inst. of Elec. Engrs. Pointing out a few of the more serious defects in the present methods, and where possible, suggesting a remedy. 2500 w. Elec Engr, Lond—Sept. 5, 1902. No. 50613 A.

## ELECTRO-CHEMISTRY.

**Accumulators.**

Deterioration of Storage Battery Plates. A. L. Marsh. Considers the principal defects which tend to shorten the life of lead batteries and also of other types, and suggests lines upon which improvements may be made. 3000 w. Elec Wld & Engr—Sept. 13, 1902. No. 50546.

The Life and Weight of Accumulators (Zur Frage der Lebensdauer und des Gewichtes der Akkumulatoren). Dr. J. Rabinowicz. A discussion of the various materials available for accumulator construction with a view to reduction in weight. 1200 w. Elektrochemische Zeitschr—Aug., 1902. No. 50773 G.

**Alkalies.**

The Electrolysis of Fused Caustic Soda and Potash (Die Elektrolyse von Geschmolzenem Aetznatron und Aetzkali). MM. Leblanc & Brode. An examination of the operation of the Castner process, as conducted at Neuhausen, in the light of the authors' experiments. Serial. 3500 w. Zeitschr f Elektrochemie—Sept. 11, 1902. No. 50770 G.

The Electrolytic Production of Chlorine and Alkalis by the Solvay-Kellner Process (Ueber Elektrolytische Gewinnung von Chlor und Alkali nach dem Solvay-Kellnerschen Quecksilber-Prozess). F. Glaser. A cathode of quicksilver and an anode of platin-iridium are used. 2500 w. Zeitschr f Elektrochemie—Aug. 7, 1902. No. 50769 G.

**Aluminum.**

The Production of Aluminum (Ueber Aluminumdarstellung). Dr. F. Haber. An examination of the electrolytic reduction of aluminum from fused salts by the direct action of the electric arc in a carbon crucible. 4500 w. Zeitschr f Elektrochemie—Aug. 21, 1902. No. 50771 G.

**Bisulphide of Carbon.**

The Manufacture of the Bisulphide of Carbon in the Electric Furnace. Edward R. Taylor. Read at meeting of the Am. Electro-Chem. Soc. Describes the electrical process developed by the writer which has proved highly satisfactory. 1000 w. Sci Am Sup—Sept. 13, 1902. No. 50492.

**Convention.**

Convention of the American Electro-Chemical Society. A report of the meeting at Niagara Falls, with abstracts of papers presented. 7700 w. Eng News—Sept. 25, 1902. No. 50672.

**Electric Smelting.**

The Ruthenberg Electric Iron Process. Marcus Ruthenberg. Extract from a paper presented to the Am. Electro-Chem. Soc. describing the author's method of fusing fine concentrates by the electric arc, into lumps suitable for the flash furnace. 1200 w. Ir Age—Sept. 25, 1902. No. 50667.

**Iron Protection.**

Electrogalvanizing. C. F. Burgess and Carl Hambulchen. Discusses the electrolytic deposition of zinc as a protective coating on structural iron, its characteristics, cost, process, etc. 7200 w. Elec Wld & Engr—Sept. 13, 1902. No. 50547.

**Nitrogen.**

Fixing Nitrogen from the Atmosphere. T. C. Martin. A description of the apparatus of Bradley, in operation at Niagara Falls by which atmospheric nitrogen is converted into nitric acid by the action of electric arcs, for the manufacture of nitrates. 2300 w. Rev of Revs—Sept., 1902. No. 50328 C.

**Ozone.**

See Civil Engineering, Water Supply.

**Precious Stones.**

Formation of the Diamond by the Electric Furnace. An illustrated description of the process used by M. Moissan, giving the results attained. 1500 w. Sci Am—Aug. 30, 1902. No. 50243.

**Slimes.**

See Mining and Metallurgy, Gold and Silver.

## ELECTRO-PHYSICS.

**Alternating Currents.**

The Alternating Current Arc. C. H. Bedell. An illustrated article considering the behavior of the alternating arc when in a magnetic field. 700 w. Elec Wld & Engr—Sept. 13, 1902. No. 50545.

**Earth Currents.**

Atmospheric Electricity and Earth Currents. E. O. Walker. Reviews the opinions of various experimenters and gives an account of the writer's investigations. 2000 w. Elect'n, Lond—Sept. 12, 1902. No. 50625 A.

**Electric Waves.**

On Electromotive Wave Accompanying Mechanical Disturbance in Metals in Contact with Electrolyte. Prof. J. Chunder Bose. The full paper presented before the Royal Society upon "Response in Organic Substances," showing electromotive effects produced by molecular disturbance. Two articles, 4500 w. Elect'n, Lond—Aug. 29, Sept. 5. 1902, No. 50463, each A.

**Electromagnetism.**

Rational Electromagnetic Units. A paper contributed to the Physical Society of London, by Signor Giovanni Giorgi, explaining his system which has been recommended for adoption by a committee of an Italian Congress. 3500 w. Elec Wld & Engr—Sept. 6, 1902. No. 50443.

**Furnace.**

Electric Furnace for Laboratory Work (Fours à Chauffage Electrique pour Laboratoires). Léon Guillet. Illustrating and describing the Heraeus furnace in practical use for high-temperature laboratory investigations. 1500 w. Génie Civil —Aug. 30, 1902. No. 50725 D.

**Magnetism.**

The Magnetic Properties of Iron and Steel at Liquid Air Temperatures. C. C. Trowbridge. A brief account of investigations of this subject, giving the results obtained. Also editorial. 4000 w. Elec Wld & Engr—Aug. 30, 1902. No. 50278.

**Radiography.**

Becquerel Rays and Radioactive Substances (Ueber Becquerelstrahlen und die Radioaktiven Substanzen). Dr. F. Giesel. A review of the discoveries which have been made in radio-activity, with theories as to the source of the emitted energy. 2500 w. Zeitschr f Elektrochemie—Aug. 14, 1902. No. 50772 G.

## GENERATING STATIONS.

**Accumulators.**

See Electrical Engineering, Electro-Chemistry.

**Armatures.**

Armature Core Discs for Continuous-Current Machines. Fred W. Davies. Notes and formulae intended for assistance in designing a suitable core disc. Ill. 3000 w. Elec Rev, Lond—Aug 22, 1902. No. 50352 A.

The Heating of Toothed-Core Armatures. Fred W. Davies. Considers some of the causes of overheating. 1500 w. Elect'n, Lond—Sept. 12, 1902. No. 50626 A.

**Boston, Mass.**

The Power Plants Which Light Boston. Describes and illustrates the Atlantic Avenue, and the South Boston stations. The former supplies direct current, and the latter the street lighting circuits and alternating current. 9800 w. Engr, U S A—Sept. 1, 1902. No. 50281.

**Collectors.**

The Arrangement of Commutators and Collecting Rings (Behandlung von Kollekforen und Schleifringen). R. Hellmund. A discussion of the best arrangement of brushes and collecting and commutating rings for dynamos, with diagrams showing the effect of lubrication. 2500 w. Elektrotech Zeitschr—Sept. 11, 1902. No. 50766 B.

**Dynamo.**

The Déri Compensated Direct-Current Dynamo (Ueber Kompensirte Gleichstrommaschinen, System Déri). Frederick Eichberg. A description of the Déri system of winding by which a constant potential is secured in direct-current generators. 6000 w. Elektrotech Zeitschr—Sept. 11, 1902. No. 50765 B.

**Electric Plant.**

Electric Power, Light and Electric Welding Installation at the New Pimlico Wheel Works. Illustrated description. 3000 w. Elec Rev, Lond—Sept. 12, 1902. No. 50621 A.

**Generating Sets.**

Testing of Combined Steam-Engine and Dynamo Sets. Extracts from a paper presented to the Inst. of Civ. Engrs. by Edwin Hartree Rayner. An outline by the tests usually applied to such sets and the methods used in the testing shops of engine makers. Also editorial. 4000 w. Eng Rec—Sept. 6, 1902. No. 50447.

**Hydro-Electric Plants.**

A Low-Head Water-Power Plant at Fumay, France. From *Le Genie Civil.* Illustrates and describes the power plant of a factory which consists of water power, supplemented when necessary by a steam plant and all connected on an electric system of distribution. 1000 w. Eng Rec—Aug. 30, 1902. No. 50317.

The Hydro-Electric Station at Hagneck. Enrico Bignami. An illustrated description of an interesting Swiss water-power installation, the difficulties overcome, etc. 4300 w. Elec Rev, N Y—Sept. 13, 1902. No. 50538.

The Largest Hydro-Electrical Plant in Europe. From the *Illustrirte Zeitung.* An illustrated description of the water power of the Tessin, in Lombardy. 1000 w. Sci Am Sup—Aug. 30, 1902. No. 50-246.

The Largest Electric Water Power Station in New England. Illustrates and describes the system of the Lewiston and Auburn Co., on the Androscoggin River, Maine, and its proposed extensions. 1900 w. Elec Wld & Engr—Sept. 20, 1902. No. 50652.

The Snoqualmie Falls Power Plant. Enos Brown. Illustrations and brief description of this remarkable plant in Washington. 1600 w. Sci Am—Aug. 30, 1902. No. 50241.

The Water Power Plant of the Michigan-Lake Superior Power Co., at Sault Ste. Marie. Views and particulars relating to this recently completed plant. 2200 w. Eng News—Sept. 25, 1902. No. 50671.

Water Power Transmission for the Springfield, Mass., Lighting System. Illustrates and describes the station at Birchem Bend. 1200 w. Elec Wld & Engr—Sept. 6, 1902. No. 50441.

**Incomes.**

Incomes of Electric Stations. Alton D. Adams. An investigation of the incomes for service to commercial arc lamps, commercial incandescent lamps, electric motors and arc and incandescent street lamps, as based on the reports from stations in Massachusetts. 3800 w. Elec Rev, N Y—Sept. 13, 1902. No. 50537.

**Isolated Plant.**

The Power Plant of B. F. Keith's Theater, Boston. Describes the main features of the lighting, heating and ventilating plant, and the unusually fine equipment of this public building. Ill. 4000 w. Engr, U S A—Sept. 1, 1902. No. 50282.

**Lagos.**

The Electric Station at Lagos (Die Elektrische Centrale in Lagos). C. Hohl. A general description of the modern generating station for lighting, power and tramway service, in the capital of British West Africa. 3000 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50758 B.

**Parallel Driving.**

Parallel Operation of Direct-Connected Alternators. P. C. Oscanyan. Describes investigations made by the writer of the pendulum action which sometimes causes the generators to go out of step. 1200 w. Elec Wld & Engr—Sept. 13, 1902. No. 50-548.

Engine Governing and Parallel Running of Alternators. Abstract of report of a special committee of the International Soc. of Elec. Engrs. on the best method of running alternators in parallel. 1500 w. Eng Rec—Sept. 20, 1902. No. 50645.

**Phase Displacement.**

A Simple Demonstration of Phase Displacement in Alternating Circuits (Einfache Demonstration der Phasenverschiebung in Wechselstromkreise). W. Kohlrausch. Describing a mechanical model by means of which phase displacement may be given ocular demonstration. 1200 w. Elektrotech Zeitschr—Sept. 11, 1902. No. 50767 B.

**Power Stations.**

See Street Railways and Tramways.

**Sunderland.**

Sunderland Electricity Works. Notes and illustrations descriptive of this station and the extensive work recently carried out. 3000 w. Elec Engr, Lond—Sept. 12, 1902. No. 50614 A.

**Switchgears.**

Future Types of Switchgears. W. E. Warrilow. Describes recent types in American and Continental stations, commending the cellular type of gear. 2000 w. Elec Engr, Lond—Sept. 5, 1902. No. 50612 A.

**Three Phase.**

Three-Phase Power Plant in a Welsh Lead Mine. Illustrated description of the plant in the Frongoch mine, in Cardiganshire. 700 w. Elec Rev, Lond—Sept. 12, 1902. No. 50619 A.

**Transformers.**

Testing the Efficiency of Transformers. Fred W. Ballard. Gives directions for testing for core losses, copper losses, etc. Ill. 1800 w. Engr, U S A—Sept. 15, 1902. No. 50664.

The Station Transformer Hazard. George P. Low. Abstract of a paper read before the Fire Underwriters' Assn. of the Pacific. Considers the practice of immersing the transformer in oil and the dangers arising, suggesting their elimination by the confinement of the transformers in separate fire-proof buildings. 1600 w. Jour of Elec—Aug., 1902. No. 50254.

## LIGHTING.

**Address.**

The Scope of Lighting Technology (Die Ziele der Leuchttechnik). Otto Lummer. Addresses delivered before the Elektrotechnischen Verein in Berlin, reviewing in an exhaustive manner the subject of artificial illumination, with especial reference to electric lighting. An extensive bibliography is appended. Two articles; 20000 w. Elektrotech Zeitschr—Aug. 28, Sept. 4, 1902. No. 50763 each B.

**Arc Lighting.**

Development of Arc Lighting Apparatus from 1810 to 1902. W. D'A. Ryan. Read before the Canadian Elec. Assn. An illustrated review of the most important points in the development of arc lamps. 2800 w. Can Elec News—Sept., 1902. No. 50483.

**Nernst Lamp.**

Experience with the Nernst Lamp. Extracts from the discussion at the recent Cincinnati Electric Light convention on this subject. 4300 w. Am Elect'n—Sept., 1902. No. 50481.

**New South Wales.**

Electric Lighting in Sydney. Brief illustrated description of the Empire Company's station. 1500 w. Aust Min Stand —Aug. 14, 1902. No. 50607 B.

**Pioneers.**

Staite and Petrie's Electric Light—1846—1853. J. J. Fahie. An illustrated article giving an account of the labor of two early workers in this field and what they accomplished. Also editorial. 4800 w. Elec Engr, Lond—Aug. 29, 1902. Serial. 1st part. No. 50458 A.

## MEASUREMENT.

**Alternating Currents.**

The Measurement of Power in Alternating Current Circuits. W. G. Rhodes. An explanation of methods of deducing formulae for the measurement of power in alternating current circuits without having recourse to the calculus. 600 w. Elec Rev, Lond—Sept. 5, 1902. No. 50563 A.

**Materials.**

Rules for the Construction and Testing of Installation Material (Vorschriften für die Konstruktion und Prüfung von Installationsmaterial). The provisional rules of the Verband Deutscher Elektrotechniker, to be given a trial for one year. 2000 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50759 B.

**Meter.**

A New Alternating-Current Meter (Ein Neuer Wechselstromzähler). Georg Stern. The new meter of the Union Elektrizitäts-Gesellschaft, of the induction motor type, is described in detail, together with method of calibrating. 4500 w. Elektrotech Zeitschr—Aug. 28, 1902. No. 50762 B.

**Oscillograph.**

Blondel Oscillograph—New 1902 Type. C. L. Durand. Illustrated description of an instrument for observing all kinds of varying electrical phenomena. 2000 w. Elec Rev, N Y—Sept. 13, 1902. No. 50540.

**Potentiometer.**

Checking Electrical Instruments. Dr. Clayton H. Sharp. Abstract of a paper read at the Mt. Washington convention of the Edison Illuminating Companies. Describes methods of measurement with the potentiometer, used with a standard cell. 1800 w. Elec Wld & Engr—Sept. 20, 1902. No. 50654.

**Standards.**

Standards for Electrical Generators and Transformers (Normalien für Elektrische Maschinen und Transformatoren). The provisional standards of the Verband Deutscher Elektrotechniker, which have been under trial for the past year and are to be given another year's trial. 4000 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50760 B.

**Testing.**

See Electrical Engineering, Generating Stations.

**Transformers.**

A Practical Method of Calculating Transformer Reactance. Presents a simple method of arriving at a basis from which the short circuit reactance of transformers of ordinary commercial design may be accurately predicted. 1000 w. Elec Rev, Lond—Sept. 5, 1902. No. 50562 A.

## POWER APPLICATIONS.

**Canal Haulage.**

Electrically-Operated Canals in Belgian Coal Mining Districts. Frank C. Perkins. Illustrates and describes the operation of the Charleroi Canal in Belgium, and reports the progress in electric propulsion generally. 1000 w. Marine Engng —Sept., 1902. No. 50300 C.

**Cement Works.**

The Pacific Portland Cement Company's Works. Watson Vredenburgh, Jr. Illustrated detailed description of a hillside plant in California. The power is electrical, and the fuel for the burning and driving is obtained from the Caifornia oil fields. 2200 w. Eng Rec—Aug. 30, 1902. No. 50316.

**Coal Cutting.**

Electric Coal-Cutting Plant at the Lambton Collieries Co., Durham. An account of a visit of the N. of Eng. Inst. of Min. Engrs. to these collieries, with description of interesting methods observed. 2500 w. Col Guard—Sept. 12, 1902. No. 50639 A.

**Comstock Lode.**

Recent Application of Electrical Power on the Comstock Lode. Leon M. Hall. Read at the convention of the Pacific Coast Elec. Trans. Assn. Illustrates and describes the most important features of the new installation. 4700 w. Jour of Elec—Aug., 1902. No. 50252.

**Cranes.**

Electric Cranes. Waldon Fawcett. Illustrates and describes various types. 2400 w. Elec Rev, N Y—Sept. 13, 1902. No. 50541.

Sixty-ton Electric Traveling Crane (Pont Roulant Electrique de Soixante Tonnes). Ch. Dantin. Illustrated description of an electric traveling crane of 30 metres span, and 60 metric tons capacity, at the Chaussade steel works, at Guérigny, France. 1500 w. 1 plate. Génie Civil—Aug. 16, 1902. No. 50719 D.

**Direct-Current.**

The Up-Keep of the Direct Current Motor and Its Accessories. Alfred H. Mayes. Considers the causes of trouble to which a motor is liable, and the precautions to be taken. 2000 w. Elec Rev, Lond—Sept. 12, 1902. No. 50616 A.

**Drilling.**

Electrical Tests of Power Required for Drilling Cast Iron from the Solid. Data obtained in a series of tests to determine the power required to operate drilling machines with different sizes of drills. 1000 w. Am Mach—Sept. 18, 1902. No. 50585.

**Drying Oven.**

An Improved Drying Oven. Edmund S. Smith. Brief illustrated description of an electric oven, simple and easily constructed. 600 w. Sci Am—Sept. 20, 1902. No. 50599.

**Gas Works.**

Electrically Operated Appliances in Gas and Electric Works. George C. Holberton. Read before the Pacific Coast Gas Assn. Illustrated description of electrical appliances found useful in gas works, with remarks on their convenience, economy, etc. 2500 w. Am Gas Lgt Jour—Sept. 22, 1902. No. 50658.

**Hoisting.**

The Influence of Electricity upon the Development of Hoisting Machinery (Die Lastenförderung unter dem Einfluss der Elektrotechnik). H. Kammerer. A general discussion of the adaptability of the electric motor to hoisting machinery, and the modifications which have resulted from its use. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 13, 1902. No. 50575 D.

**Machine Driving.**

An Electrically Operated Manufacturing Plant. Illustrated description of the displacement of steam by electricity as motive power in the Lister Agricultural Chemical Works at Newark, N. J. 3000 w. Am Elect'n—Sept., 1902. No. 50480.

Electricity as a Motive Power for Machine Shops. With special reference to the electrical equipment of the William R. Trigg Co., Richmond, Va., which is illustrated and described. 4800 w. Mach, N Y—Sept., 1902. No. 50384.

Electric Power in Iron Works (Emploi de l'Electricité dans le Forges). A. Abraham. With especial reference to the use of electric driving in forges and rolling mills, with examples from French and German practice. 3000 w. Génie Civil—Aug. 30, 1902. No. 50723 D.

Power, Lighting and Heating at the Du Bois Shops of the Buffalo, Rochester & Pittsburg Ry. Illustrated description of an electric and compressed air system of power transmission, with power, lighting, compressed air and heating all served from a central station. 2500 w. Eng Rec —Sept. 6, 1902. No. 50444.

The Electrical Driving of Machinery; Its Economy and Advantages. Frank Broadbent. A discussion of this subject illustrated by examples. 2800 w. Elec Rev, Lond—Sept. 12, 1902. No. 50615 A.

The Power Equipment of the Westinghouse Works at Trafford Park. A brief general description with illustrattions. 1800 w. Elec Rev, Lond—Sept. 12, 1902. No. 50618 A.

**Mining Plant.**

Electric Plant in the Grand Duke Frederick Iron Mine at Zakarfalu, Hungary (Die Elektrischen Anlagen des Erzherzoglich Friederich'schen Eisensteinbergbaues in Zakarfalu). H. Drolz. A description of the utilization of the water power of the Gölnitz for the light and power plant of the mines at Zakarfalu, including the transport of iron ore to the railway, 5 kilometres distant. Serial. Part I. 2 plates. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 16, 1902. No. 50738 B.

Kalgoorlie Electric Power. C. E. Crocker. A description of this plant the principal purpose of which is to supply electric current to the mines. 1700 w. Aust Min Stand—July 17, 1902. No. 50331 B.

The Kalgoorlie Electric Power and Lighting System. Illustrated description of the first large power distribution scheme in Australia, which furnishes over 15,000 H. P. for these gold mines. 1800 w. Elec Rev, Lond—Sept. 12, 1902. No. 50620 A.

**Motor Losses.**

Losses in a Large Non-Synchronous Motor (Ueber Verluste an einem Grossen Asynchronmotor). F. Bodensteiner. Data and results of a test of a Siemens & Halske motor of 170 h. p.; showing an efficiency of 92.4 per cent. at full load. 1200 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50757 B.

**Motors.**

A New Method of Starting Induction Motors (Ein Neues Verfahren zum Anlassen von Induktionsmotoren). Alfred Schwartz. An examination of the operation of the induction motor and the condition of starting under load. A centrifugally operated clutch throws the load on only when full speed is attained. 4000 w. Elektrotech Zeitschr—Sept. 4, 1902. No. 50764 B.

Electric Motors. Definitions and Functions. F. J. A. Matthews. Explains the function of the various parts of the dynamos, and the definition of some of the commoner terms used. 3800 w. Mech Engr—Aug. 23, 1902. Serial. 1st part. No. 50337 A.

**Ore Handling.**

Electricity in Ore Handling. Waldon Fawcett. Describes the application of electricity to this work, especially in loading and unloading. Ill. 1500 w. Am Mfr —Aug. 28, 1902. No. 50290.

**Storage Batteries.**

Storage Batteries in Mills and Factories. E. Vail Stebbins. Describes the construction of a battery and its action, and the extent to which storage batteries may be put in mills and factories to equalize the load. Ill. 4500 w. Jour Assn of Engng Soc's—July, 1902. No. 50322 C.

## TRANSMISSION.

**Canada.**

The Largest Electrical Transmission in Canada. Alton D. Adams. Illustrated description of the plant of the Hamilton Electric Light and Cataract Power Company. 1200 w. Elec Rev, N Y—Aug. 30, 1902. No. 50255.

**High-Tension.**

Pressure Rise in High-Tension Transmission. W. B. Woodhouse. Considers the causes of excessive pressure rise and the means of safeguarding the system against undue stress. 1600 w. Elect'n, Lond—Sept. 5, 1902. No. 50559 A.

**Lines.**

Construction of Transmission Lines. A portion of a paper by George H. Lukes read at the recent convention of the Edison Illuminating Companies. Treats of line construction, switching, regulation and rates. 3000 w. Elec Wld & Engr—Sept. 20, 1902. No. 50655.

**Long Distance.**

Commercial Success in Long-Distance Electric Power Transmission. Extract from the Presidential address of Dr. Chas. W. Van Norden, before the Pacific Coast Elec. Trans. Assn. 1200 w. Eng News—Sept. 4, 1902. No. 50399.

Long Distance Power Transmission. F. A. C. Perrine. A study of some of the problems to be solved in securing continuity and regulation. 5000 w. Sci Am Sup—Sept. 13, 1902. No. 50493.

The Physical Limits of Electric-Power Transmission. Alton D. Adams. A discussion of the possibilities of high voltages and the methods required in apparatus and line for long-distance power transmission. 3000 w. Engineering Magazine—October, 1902. No. 50782 B.

**Pike's Peak.**

The Pike's Peak Power Transmission. R. M. Jones. Illustrated description. 3500 w. Jour of Elec—Sept., 1902. No. 50695.

## MISCELLANY.

**Agriculture.**

The Relations of Agriculture to Electrotechnics (Was Hat die Elektrotechnik von der Landwirthschaft zu Erwarten). Dr. Robert Haas. A discussion of the possibilities of the application of electricity to agricultural districts, especially in connection with the distribution of light and power. 4500 w. Elektrotech Zeitschr—Aug. 28, 1902. No. 50761 B.

**Statistics.**

Statistics of Electrical Progress. Reviewing the report prepared by Thomas Commerford Martin on the manufacture of electrical apparatus and supplies. 1800 w. Elec Rev, N Y—Sept. 6, 1902. No. 50390.

U. S. Census Report on Electrical Manufactures. A review of the report compiled by Mr. T. C. Martin, giving tabulated information and discussing the report in general. 5000 w. Elec Wld & Engr—Sept. 20, 1902. No. 50653.

# GAS WORKS ENGINEERING

**Birmingham, Eng.**

The Windsor Street (Birmingham) Gas-Works and the New Coke Plant. On the methods introduced at this plant with an illustrated description of the new coke conveyor. 1400 w. Jour Gas Lgt—Sept. 9, 1902. No. 50577 A.

**Comparisons.**

Relative Attractiveness of Different Artificial Lights. Reviews the improvements in artificial lighting, especially as affecting England. 2500 w. Jour Gas Lgt—Aug. 19, 1902. No. 50354 A.

**Engineers.**

The Rise and Recognition of the Engineer, with Especial Reference to Gas Engineering. L. P. Lowe. Read at meeting of the Pacific Coast Gas Assn. 3200 w. Am Gas Lgt Jour—Sept. 22, 1902. No. 50657.

**Gas Power.**

See Mechanical Engineering, Special Motors.

**Gas Stoves.**

Gas-Cookers—Desirable to Gas Companies and Consumers. D. W. Lyme. Read before the Irish Assn. of Gas Mgrs. Concerning increasing the sale of gas through the medium of gas-cookers. Also discussion. 3000 w. Jour Gas Lgt—Aug. 26, 1902. No. 50341 A.

The Housing of the Gas Cooking Stove. Norton H. Humphreys. Suggesting the placing of these stoves in a place prepared for them, with a ventilating flue to carry off the steam and products of combustion. 2200 w. Jour Gas Lgt—Sept. 9, 1902. No. 50578 A.

**Gas Works.**

See Electrical Engineering, Power Applications.

**Ireland.**

Gas Affairs in the West of Ireland. T. J. Reid. Read before the Irish Assn. of Gas Mgrs. An account of the conditions prevailing, and what has been done to modernize some of the works. Discussion. 6400 w. Gas Wld—Aug. 23, 1902. No. 50347 A.

**Leakage.**

Gas Leakage in American Cities. James C. Bayles. Considers the economic and hygienic aspects, and how to remedy the evil. Ill. 5000 w. Munic Jour & Engr—Sept., 1902. No. 50293 C.

**Meters.**

The Prepayment Meter System in Sligo. C. B. Tully. Read before the Irish Assn. of Gas Mgrs. Describes the satisfactory introduction of these meters. Discussion. 2200 w. Gas Wld—Aug. 23, 1902. No. 50348 A.

**Mill Lighting.**

Incandescent Gas Lighting in Mills. Presidential address of Mr. Laurence Bell, before the Waverly Assn. of Gas Mgrs. Discusses the difficulties to overcome and how they may be conquered, and related matters. 2000 w. Gas Wld—Sept. 13, 1902. No. 50611 A.

**Municipal Plants.**

Cost of Light in Municipal and Private Gas and Electric Plants. Alton D. Adams. A comparison between two groups of towns in Massachusetts as to the price of gas to private consumers, the cost of electric street lighting, and the net earnings on the invested capital. In one group the plants are owned by private corporations, in the other by the municipality. 900 w. Munic Engng—Sept., 1902. No. 50330 C.

**Photometry.**

Effect of Varying the Conditions of Combustion on the Illuminating Power of Coal Gas. H. Leicester Greville. Gives tabulated results of investigations of the light of different grades of coal gas under varying conditions to determine the best method of developing the maximum light. 800 w. Jour Gas Lgt—Aug. 19, 1902. No. 50355 A.

The History of English Photometry. Vivian B. Lewes, in *Il Gaz*. A sketch of the history during the last 200 years. 6000 w. Gas Wld—Sept. 6, 1902. No. 50556 A.

**Purification.**

An Experiment on the Principles of Purification. E. C. Jones. Read before the Pacific Coast Assn. Also discussion. Describes experiments with two types of purifiers, giving results. Ill. 4500 w. Am Gas Lgt Jour—Sept. 8, 1902. No. 50420.

**Retorts.**

Inclined Retorts. E. Merz. Abstract translation of a paper read before the German Gas Assn. Deals with the objections raised against inclined retorts, showing them unfounded. 1200 w. Gas Wld—Sept. 6, 1902. No. 50557 A.

**Sulphate.**

Sulphate Manufacture in Great Britain. Extracts from the report of R. Forbes Carpenter to the Local Government Board, showing the production from the gas industry, and matters relating. 3000 w. Gas Wld—Aug. 30, 1902. No. 50456 A.

**Sulphuretted Hydrogen.**

Estimation of Sulphuretted Hydrogen in Minute Quantities in Coal Gas. W. J. Dibdin. Read before the Soc. of Public Analysts. Describes methods used and results obtained. Also discussion. 1800 w. Jour Gas Lgt—Sept. 9, 1902. No. 50579 A.

The Action of Ferrous Thiosulphate on Sulphuretted Hydrogen. An account of experiments carried out by Mr. Linder and given in report of R. Forbes Carpenter. 2000 w. Jour Gas Lgt—Sept. 2, 1902. No. 50466 A.

**Water Gas.**

Dellwik-Fleischer Water-Gas Plant at Nuremberg. From the *Journal für Gasbeleuchtung*. Particulars concerning this plant. 2000 w. Jour Gas Lgt—Aug. 19, 1902. No. 50356 A.

## INDUSTRIAL ECONOMY

**Address.**

Prof. James Dewar's Presidential Address to the British Association. Abstract. Discusses education, the importance of science, the value of applied chemistry, etc. 5200 w. Elect'n, Lond—Sept. 12, 1902. Serial. 1st part. No. 50624 A.

**American Workmen.**

Fifty Years Among American Workingmen. Egbert F. Watson. Observations from the writer's experience, describing the social and material condition of fifty years ago, the workmen, the effect of increased immigration, development, etc. 4000 w. Ir Age—Sept. 18, 1902. No. 50549.

**Bonus System.**

The Bonus System of Rewarding Labor. H. L. Gantt. Explains the work of Mr. Fred W. Taylor, as this system was an outgrowth from his investigations, showing the advantages and the working of the system. 2000 w. Rev of Revs—Sept, 1902. No. 50326 C.

**Commerce.**

Problems of the Pacific—The Commerce of the Great Ocean. O. P. Austin. Shows reasons why the United States will always possess exceptional facilities for commerce with the countries touched by the Pacific Ocean. Ill. 6000 w. Nat Geog Mag—Aug., 1902. No. 50288 C.

**Competition.**

The Competition of the United States (Der Wettbewerb der Vereinigten Staaten). H. Schwabe. A review of the development of the iron and steel industries of the United States, showing the influence of its competition upon German trade. 3000 w. Glasers Annalen—Sept. 1, 1902. No. 50717 D.

**Contracts.**

Separate *versus* General Contracts. Informal discussion of whether in contract work, either public or private, it is preferable to make contracts for the different branches of trade involved, or to combine all under one general contract. 6000 w. Pro Am Soc of Civ Egrs—Aug., 1902. No. 50429 E.

**Cost-Keeping.**

Co-operative and Mechanical Aids to Work-Shop Cost-Keeping. R. P. Link. Read before the Inst. in Sunderland. Calls attention to the method of utilizing automatic machines to control the keeping of costs in shops. Also discussion. 4800 w. Trans of N E Coast Inst of Engrs & Shipbldrs—July, 1902. No. 50340 D.

Unit Costs of Work in Progress. Informal discussion of whether it is possible and desirable to keep accounts of cost of work in such a manner as to ascertain unit costs on each class of work. 3300 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50430 E.

The Cost-Keeping Systems of an Ohio Jobbing Foundry. Outlines the system used in a foundry employing a large force of workmen on a great variety of work. 1200 w. Ir Trd Rev—Sept. 4, 1902. No. 50382.

**Düsseldorf Exposition.**

Salient Features of the Düsseldorf Exposition. Harrington Emerson. A richly illustrated account of the Rhenish-Westphalian exposition at Düsseldorf as indicating Germanv's progress in engineering and metallurgy. 4000 w. Engineering Magazine—October, 1902. No. 50783 B.

The Düsseldorf Exposition of 1902 (L'Exposition Régionale de Düsseldorf en 1902). P. Dujardin. A general review of the Düsseldorf exposition from a French point of view. 2500 w. Génie Civil—Aug. 16, 1902. No. 50718 D.

See also Mining and Metallurgy.

See also Railway Engineering.

**Education.**

New Powers and New Responsibilities (Neue Rechte—Neue Pflichten). W. v. Oechelhaeuser. The Presidential address before the Düsseldorf meeting of the Verein Deutscher Ingenieure, dealing with problems of engineering education. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 23, 1902. No. 50707 D.

Prof. John Perry's Presidential Address Before Section G of the British Association. Discusses the subject of education especially as applied to engineering. 5000 w. Elect'n, Lond—Sept. 12, 1902. Serial. 1st part. No. 50627 A.

**Iron Industry.**

The Foundations of the American Iron Industry. Archer Brown. A critical review of the causes, conditions and probable duration of the present era of prosperity in the American Iron Trade. 4000 w. Engineering Magazine—October, 1902. No. 50781 B.

**Irrigation.**

Irrigation Works. Informal discussion of the question whether the National Government should undertake the construction and operation of irrigation works. 9800 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50433 E.

**Labor.**

The Shop Clubs Act, 1902. Editorial discussion of an act recently passed which places further statutory restrictions upon the liberty of employers in dealing with their men. 1400 w. Engng—Aug. 29, 1902. No. 50472 A.

Wages and Hours of Labor in 1901. Review of the last annual report of the Labor Department of the Board of Trade in England. 2500 w. Engng—Sept. 5, 1902. No. 50573 A.

**Locomotive Trade.**

Competition for the Foreign Locomotive Trade. Extracts from a correspondence between the Secretary of State for India and certain British firms as to competition between German and British builders of locomotives. 3300 w. R R Gaz—Aug. 29, 1902. No. 50271.

**Municipal Ownership.**

Municipal Trading. Robert P. Porter. Read at Belfast meeting of the Brit. Assn. for the Adv. of Science. Discusses this subject as related to English methods, giving the history of the same industries as carried on in the United States, and considering the objections to municipal trading as carried on in England. 6000 w. Engng—Sept. 19, 1902. No. 50817 A.

**Shop Records.**

Workshop Records. A Review and Comparison of Existing Methods, with Special Reference to the Use of Cards and Files Instead of Books. George Parker. Read before the meeting in South Shields. Also discussion and 2 plates. 13400 w. Trans of N E Coast Inst of Engrs & Shipbldrs—July, 1902. No. 50339 D.

**South Africa.**

South Africa from an Engineer's Point of View. The present article is a review of some recent investigations by a general trade commission. 900 w. Engr, Lond—Sept. 5, 1902. Serial. 1st part. No. 50565 A.

**Statistics.**

The Census of Manufactures. S. N. D. North. Information concerning the cost and work of preparing valuable statistics in the industries, and a review of the more important facts of this latest census of manufactures. 4200 w. Rev of Revs—Sept., 1902. No. 50325 C.

**Stream Control.**

See Mechanical Engineering, Hydraulics.

**Strikes.**

Is the Coal Strike a Conspiracy? Discussion of the anthracite coal strike, especially the attitude of the operators. 2000 w. Gunton's Mag—Sept., 1902. No. 50-287.

**Tariff.**

The Iron Tariff in the First Reading of the Tariff Commission (Die Eisenzölle in der I Lesung der Zolltarifcommission). The full tabular changes proposed in the German tariff on iron; with editorial comments. 3000 w. Stahl u Eisen—Aug. 15, 1902. No. 50748 D.

**Technical Dictionary.**

The Technolexicon (Technolexikon). The progress report of the editor, Dr. Hubert Jansen upon the new technical dictionary in English, French and German, now being prepared by the Society of German Engineers. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 30, 1902. No. 50711 D.

**Works Management.**

Money-Making Management for Workshop and Factory. Charles U. Carpenter. Mr. Carpenter's concluding paper is devoted to the finding and recording of costs, and to a general summary of the whole series. 4000 w. Engineering Magazine—October, 1902. No. 50787 B.

## MARINE AND NAVAL ENGINEERING

**Battleship.**

Laying the Keel of the New Battleship "Nebraska" at the Works of Moran Bros. Company, Seattle, Wash. July 4, 1902. An illustrated article more particularly describing the plant where this vessel is under construction. 1500 w. Sci Am Sup—Aug. 30, 1902. No. 50244.

The French Battleship Republique. Illustrated description of one of six new battleships which are building or projected, showing a change in French shipbuilding policy. Also editorial. 2500 w. Engr, Lond—Sept. 12, 1902. No. 50632 A.

United States Battleships Connecticut and Louisiana. Describes and illustrates these recently authorized vessels and their equipment. 2500 w. Engr, Lond—Aug. 29, 1902. No. 50474 A.

**Bearings.**

Roller Bearings for Marine Engines. Stephen P. M. Tasker. Discusses the advantages, and reports the test made of the steam yacht "Sagamore." 800 w. Marine Engng—Sept., 1902. No. 50302 C.

**Clyde Works.**

Clyde Trust New Works. A description of new works in progress and new features recently introduced. 2500 w. Engr, Lond—Sept. 12, 1902. No. 50633 A.

**Destroyer.**

The Swedish Torpedo Boat Destroyer "Mode." Illustrated description of a fine boat, recently completed, with report of the official trial. 800 w. Engng—Sept. 19, 1902. No. 50815 A.

**Fast Vessels.**

On the Strength of High-Speed Vessels. M. J. A. Normand. Considers some of the causes producing fatigue that are often overlooked. 2300 w. Engng—Sept. 12, 1902. No. 50637 A.

**Lake Steamers.**

Notable New American Lake Steamboats. Illustrated description of the two latest passenger boats for the Great Lakes, the "Western States" and the "Eastern States." 1000 w. Naut Gaz—Aug. 28, 1902. No. 50247.

**Launch.**

Hospital Electric Launch. Illustration and description of a novel vessel to be used for the St. John's Guild, New York, for transferring sick children between the floating hospitals and the Seaside Hospital. 600 w. Marine Engng—Sept., 1902. No. 50305 C.

**Launching.**

The Launch of the Twin-Screw Steamer Kaiser Wilhelm II. (Der Stapellauf des Doppelschrauben-Schnelldampfers "Kaiser Wilhelm II.") Description of the launch, with details of the dimensions of the vessel, the longest yet built, being 706 feet in length. 1500 w. 2 plates. Zeitschr d Ver Deutscher Ing—Aug. 16, 1902. No. 50700D.

**Life Boat.**

The Carley Life Float. Illustration with description of a device for saving life at sea. 900 w. Am Shipbuilder—Sept. 11, 1902. No. 50477.

**Liners.**

Modern Ocean Liners. Editorial on the present position of England in this field, especially comparing it with Germany. 2700 w. Engng—Aug. 22, 1902. No. 50371A

**Naval Engineers.**

The Engineering Branch of the Royal Navy. Editorial review of a printed statement of the causes of dissatisfaction and proposed remedies. 3700 w. Engng—Aug. 29, 1902. No. 50471 A.

**Naval Manoeuvres.**

The French Naval Manoeuvres. An account of the manoeuvres carried out by the French fleets in the Mediterranean during the past month which were of more than usual interest. 4000 w. Engr, Lond—Aug. 22, 1902. No. 50360 A.

The French Naval Manoeuvres. Editorial review of this year's manoeuvres which were on an exceptionally large basis. 2800 w. Engng—Sept. 12, 1902. Serial. 1st part. No. 50634 A.

**Ocean Tramps.**

Lake-Built Ocean Tramps. Theodore Lucas. Considers the limitations of ships to be built on the lakes for ocean service and their effect on the earning possibilities of cargo steamers. 2000 w. Naut Gaz—Aug. 28, 1902. No. 50248.

**Oil Fuel.**

Report of Recent Oil Burning Installations on the Pacific Coast. Edward S. Hough and William H. Crawford, Jr. Gives illustrations showing the experience gained in marine work at the port of San Francisco. Ill. 2200 w. Marine Engng—Sept., 1902. No. 50301 C.

**Oil Motors.**

The Application of Oil Engines to Light Marine Work. Capt. C. C. Longridge. Considers the advantages and defects of these motors for marine work, and describes methods of reversing. 2200 w. Naut Gaz—Sept. 11, 1902. No. 50482.

**Repairs.**

Building a New Bottom for a Wrecked Ship. Illustrated description of the extensive repairs to the U. S. transport, McPherson, which went ashore on the South coast of Cuba. 700 w. Marine Engng—Sept., 1902. No. 50306 C.

**Shipping.**

Queer Craft Seen on My Travels in the Philippines, China and South America. E. C. Rost. Brief illustrated descriptions of strange boats. 1200 w. Sci Am—Sept. 13, 1902. No. 50490.

**Steam Engines.**

See Mechanical Engineering, Steam Engineering.

**Steamships.**

Brief History of Ocean Steamships. Lawrence Irwell. An account of some of the earliest steamers of the world, and the process of development. 5900 w. Marine Rev—Sept. 11, 1902. No. 50527.

Fishing Steamer. Description and plan

of a unique fishing steamer for service in Southern waters, to be used in gathering the catch from the fishing fleet and bringing it to market. 450 w. Marine Engng —Sept., 1902. No. 50303 C.

New Steamship Kroonland of the International Navigation Company. An illustrated detailed description of this largest ship yet built in American waters, noting features of interest in design and in construction work. 3300 w. Marine Engng—Sept., 1902. No. 50299 C.

Shallow Draught Steamer. Illustrates and describes a new feature introduced by Yarrow & Co. into screw-propelled boats of this type by reason of which great economy is claimed. 600 w. Engr, Lond—Aug. 22, 1902. No. 50364 A.

The Twin Screw Express Steamship Kaiser Wilhelm II. (Doppelschrauben-Schnelldampfer Kaiser Wilhelm II.) A general account of the new steamer of the North German Lloyd, with especial reference to the launch. 2000 w. Stahl und Eisen—Sept. 1, 1902. No. 50751 D.

**Steam Trials.**

Steam Trials of H.M.S. "King Alfred." Editorial on the performance of this armored cruiser, which was highly satisfactory. 1500 w. Engng—Sept. 5, 1902. No. 50572 A.

**Steering Gear.**

Steam Steering Gear. Arthur Masters. Considers the advantage of steam over hand gears, types of steam steering gear and methods of transmission. Ill. 3200 w. Mach, N Y—Sept., 1902. No. 50387.

**Submarines.**

Submarine Boats. Editorial review of opinions held as to the value of the submarine boat. 3700 w. Engng—Sept. 5, 1902. No. 50570 A.

**Towboat.**

Steel Towboat Vesta for the Monongahela River. Illustrated description of a boat to be used mainly in towing coal from the mines to the mills and furnaces. 3000 w. Marine Engng—Sept., 1902. No. 50-304 C.

**Towing.**

Old-Time Towing on the Detroit River. George Lansing. An illustrated article giving a review of past conditions on the St. Clair and Detroit Rivers. 2400 w. Naut Gaz—Aug. 28, 1902. No. 50249.

**Yachts.**

The Steam Yacht "Arrow"—The Fastest Boat in the World. Illustrated description of this fine yacht which recently covered a nautical mile in 1 min. 32 sec. 1600 w. Sci Am—Sept. 20, 1902. No. 50600.

# MECHANICAL ENGINEERING

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## AUTOMOBILES.

**Accumulators.**

See Electrical Engineering, Electro-Chemistry.

**Bearings.**

Adjustable Bearings a Requisite of the Practical Automobile. Albert L. Clough. Gives the writer's views and also a brief editorial disagreeing with some points. 1500 w. Horseless Age—Sept. 17, 1902. No. 50580.

**Design.**

Design and Workmanship. Albert L. Clough. Considers the failures due to design and to faulty material and workmanship in the progress of the automobile industry. 1100 w. Horseless Age—Aug. 27, 1902. No. 50250.

**Gasoline Vehicles.**

The Loomis Carbureter and Muffler. Illustrated description of articles named which have been in use for some time on gasoline vehicles. 600 w. Sci Am—Sept. 13, 1902. No. 50487.

**Harvester.**

A Giant Automobile Harvester at Work. Brief illustrated description. 200 w. Rev of Revs—Sept., 1902. No. 50327 C.

**Journals.**

Some Notes on Journal Friction. J. S. V. Bickford. Gives results of experimental investigations. 3800 w. Horseless Age—Sept. 3, 1902. No. 50413.

**Lurries.**

A Novel Type of Steam Lurry. Illustrated description of the type adopted by the Pioneer Power Co., of London, Limited. The platform extends almost the entire length, as little of the upper space as possible being taken for the driver's seat, or machinery. 2500 w. Auto Jour—Aug. 30, 1902. No. 50455 A.

Dr. Brightmore's Steam Lurry. Illustrated detailed description of this machine and its operation, describing a trial trip. 4600 w. Auto Jour—Aug. 23, 1902. No. 50345 A.

Report on the War-Office Motor Lorry Trials. Report of a test made of self-propelled lorries to determine their capabilities for military purposes. 900 w. Engr, Lond—Sept. 5, 1902. No. 50567 A.

**Motors.**

Automobiles and Motors (Automobiles

et Moteurs). Eugène Brillié. Describing the double-acting internal combustion motor of the author's design, and its applications to mechanically propelled vehicles. 5000 w. Bull Soc d'Encour—Aug. 31, 1902. No. 50735 G.

Petrol Motor Troubles and Their Location. Directions for the care of petrol motors, and for finding out the cause of troubles. 1500 w. Motor Car Jour—Aug. 23, 1902. No. 50346 A.

**Races.**

The Brighton Beach Races. An illustrated report of these races held under the auspices of the Automobile Club of Long Island. 1400 w. Horseless Age—Aug. 27, 1902. 50251.

**Resistance.**

Traction, Grade and Air Resistance. Reynold Janney. Explains method of calculation, giving chart. 1200 w. Horseless Age—Sept. 17, 1902. No. 50581.

**Steam Trucks.**

Steam Motor Trucks. Illustrated description of the steam trucks made by the Morgan Motor Co., Worcester, Mass. 1500 w. Mach, N Y—Sept., 1902. No. 50388.

**Trials.**

Automobile Clubs 650 Miles Reliability Trial. A continued illustrated description of each day's journey, with editorial remarks. 8000 w. Auto Jour—Sept. 13, 1902. No. 50609 A.

Some Mechanical Details Noted in the 650 Miles Trials. Comments with illustrations. 3800 w. Autocar—Sept. 13, 1902. No. 50610 A.

The Meeting at Deauville. An illustrated account of speed tests, the most successful yet held. 4600 w. Autocar—Sept. 6, 1902. No. 50555 A.

The 650 Miles Reliability Trials of the A. C. G. B. I. An illustrated account of the trials with editorial. 7500 w. Auto Jour—Sept. 6, 1902. No. 50554 A.

## HYDRAULICS.

**Building Supply.**

Water Supply System in the Maiden Lane Building, New York. Illustrated description of the installation for an 18-story office building. 1300 w. Eng Rec—Sept. 6, 1902. No. 50450.

**Flow.**

New Ways of Measuring Water. Information for the use of farmers who irrigate their land, given by Director Samuel Fortier of the Montana Experimental Station. 1400 w. Sci Am—Sept. 13, 1902. No. 50486.

The Flow of Water in Wood Pipes. Theron A. Noble. Gives a brief illustrated description of the gravity supply of Seattle, Wash, and discusses a series of experiments conducted by the writer. 8000 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50427 E.

**Hydro-Electric Stations.**

See Electrical Engineering, Generating Stations.

**Nozzles.**

Discharge Nozzles for High Head. W. Stuart Smith. Discusses improperly shaped nozzles and their effects. Ill. 2800 w. Jour of Elec—Aug., 1902. No. 50253.

**Plumbing.**

The Range Boiler and Water Front. M. L. Kaiser. An illustrated article discussing the right and wrong ways of setting and connecting of the range boiler and water front. 4500 w. Met Work—Sept. 20, 1902. No. 50598.

**Pumping Engines.**

How to Obtain the Best Results in Small Pumping Stations. Harry F. Gibbs. How to get the best of the existing conditions is discussed, considering points of importance. 2400 w. Jour N E W Wks Assn—Sept., 1902. No. 50436 F.

Small Pumping Engines. Topical discussion by William F. Codd and D. N. Tower of plants equipped with oil-engines. Ill. 1000 w. Jour N E W Wks Assn—Sept., 1902. No. 50437 F.

**Pumps.**

Improved Steam Pumping Machinery (Einige Neuere Pumpmaschinen mit Dampfbetrieb). H. Becher. Data and results of tests of recent waterworks pumping engines built by Kuhn of Stuttgart. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 23, 1902. No. 50706 D.

Rotative Pumping. John Richards. A review of the development of this class of machinery, especially describing the Sulzer pumps, and the principles of the turbine type. Ill. and discussion. 8000 w. Jour Assn of Engng Socs—Aug., 1902. No. 50693 C.

**Turbines.**

Notes on the History of Turbine Development in America. A. C. Rice. An interesting review of water-wheel development, especially of the turbine design. 3300 w. Eng News—Sept. 18, 1902. No. 50588.

**Water Power.**

The Control of Non-Navigable Streams by the National Government. Informal discussion in view of the numerous disasters caused by the contracting of channels, or the damming of small streams, whether they should not be under the control of the national government. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50432 E.

Water Power Projects at Joliet, Ill. An explanation of projects now before the courts for a decision as to their respective rights, showing the general situation. Ill. 900 w. Eng News—Sept. 4, 1902. No. 50401.

## MACHINE WORKS AND FOUNDRIES.

**Bonus System.**

See Industrial Economics.

**Castings.**

Casting a Round Tank. R. H. Palmer. Illustrates and describes one of the ways of molding and pouring a tank of this kind. 1100 w. Am Mach—Aug. 28, 1902. No. 50261.

The Calculation of the Weight of Castings with the Aid of the Planimeter. C. M. Schwerin. Describes a graphic method for estimating the weight of a casting when the cross-section is not a uniform geometrical figure. 700 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50-678 C.

**Cataloging.**

Cataloging Small Machine Parts. L. P. Alford. Describes a system used in cataloging and arranging the data regarding the small parts of about 150 machines. 2000 w. Am Mach—Sept. 25, 1902. No. 50697.

**Chain Making.**

The Locke Steel Chain. Illustrated description of this automatic machine made chain, noting the operations, and commending the product. 1200 w. Engng—Aug. 22, 1902. No. 50370 A.

**Corkscrews.**

A Machine for Twisting Corkscrews. Joseph V. Woodworth. Illustrated description of the machine and its operation. 400 w. Am Mach—Sept. 25, 1902. No. 50696.

**Cost-Keeping.**

See Industrial Economics.

**Cranes.**

Counterbalances for Locomotive Cranes. Robert H. Kirk. Gives a graphical method of determining the quantity of counter weight for locomotive cranes. 1200 w. Am Mach—Sept. 18, 1902. No. 50583.

Notes on Crane Design. A. D. Williams. A discussion of points relating to crane wheels. Ill. 1000 w. Am Mach—Sept. 11, 1902. No. 50501.

See Electrical Engineering, Power Applications.

**Dies.**

Blanking Dies. Joseph V. Woodworth. Concerning the making and using of piercing and blanking dies. Ill. 2500 w. Mach, N Y—Sept., 1902. No. 50386.

The Making and Use of Simple Dies. Peter Chiampon. Illustrated descriptions of a number of dies found very useful in the average machine shop. 1200 w. Am Mach—Sept. 25, 1902. No. 50698.

**Draughtsmen.**

The Relations of the Draughtsman to the Workshop. W. H. Booth. A discussion of this fundamental question of efficient shop organization including the preparation and execution of designs for engineering work. 3000 w. Engineering Magazine—October, 1902. No. 50788 B.

**Drilling.**

See Electrical Engineering, Power Applications.

**Drills.**

Use of Ratchet and Other Hand-Machine Drills in the Cleveland Mines. William Charlton. Read before the N. of Eng. Inst. of Mech. & Min. Engrs. Brief account of the practice in these mines and the advantages. 1500 w. Ir & Coal Trds Rev—Sept. 19, 1902. No. 50820 A.

**Foundry Operation.**

Important Questions in Connection with Foundry Operation (Wichtige Frage im Giessereibetriebe). A comparison of German and American practice, showing the advantages of mechanical transport. Serial. Part I. 3000 w. Stahl und Eisen—Sept. 1, 1902. No. 50753 D.

**Grinder.**

Disc Grinder. Illustrated description of a 20-inch universal disc grinder of the "mechanical fitter" type manufactured in England. 800 w. Engr, Lond—Aug. 22, 1902. No. 50367 A.

**Hardening.**

Steel and Its Treatment. E. R. Markham. Discussing methods of heating of steel for hardening, in the present article. Ill. 2700 w. Mach, N Y—Sept., 1902. No. 50385.

**Hoisting.**

Determining the Size of Hoisting Plants. Edward B. Durham. Discusses methods of calculating. Ill. 5500 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50681 C.

**Machine Design.**

A Tendency in Machine Design. Editorial mainly discussing the tendency to smoothness of outline in steam-engine practice. 1800 w. Engng—Sept. 5, 1902. No. 50571 A.

**Machine Driving.**

See Electrical Engineering, Power Applications.

**Machine Shops.**

A Visit to the Works of the General Electric Company. Lyman B. Thompson. An illustrated detailed description of these extensive works. 5800 w. Am Mach—Sept. 4, 1902. No. 50440.

The American Steel Casting Company's New Plant at Alliance. Illustrated detailed description. 2500 w. Ir Age—Sept. 25, 1902. No. 50669.

The Ferranti Works at Hollinwood. Illustrates and describes the works and some of the products of one of the oldest electrical engineering concerns in England. 2200 w. Elec Times—Aug. 28, 1902. Serial. 1st part. No. 50452 A.

The New Machine Works of Louis Soest & Co. (Neuanlage der Maschinenfabrik Louis Soest & Co.) W. Grueber. Describing an important new plant near Düsseldorf, devoted to the manufacture of steam and gas engines, as well as mining and general machinery. 2500 w. Stahl und Eisen—Sept. 1, 1902. No. 50752 D.

The Science of the Workshop. William Taylor. Read at Belfast meeting of the Brit. Assn. for the Adv. of Science. Discusses materials, processes and tools, tracing the foundation of this science. 4500 w. Engng—Sept. 19, 1902. No. 50818 A.

The Works of Messrs. Belliss and Morcom, Limited. An illustrated description of these works which have attained a high reputation as makers of high-speed engines, and also of their equipment. 5000 w. Engng—Sept. 19, 1902. No. 50814 A.

**Machine Tools.**

Improvements in Machine Tools (Neuerungen im Werzeugmaschinenbau). Hermann Fischer. Describing especially minor details of construction in recent German lathes and drilling machines. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 23, 1902. No. 50705 D.

**Machine Work.**

Inaccurate Machine Work on Cylinders and Pistons. Albert L. Clough. A criticism on work observed on three horizontal gasoline vehicle engines. 1200 w. Horseless Age—Sept. 10, 1902. No. 50496.

**Mannesmann Tubes.**

Notes on the Manufacture of Weldless Steel Tubes by the Mannesmann Process. J. H. H. Barrée. Read before the South Wales Inst. of Engrs. An illustrated article fully describing the process. 3000 w. Ir & Coal Trds Rev—Aug. 22, 1902. No. 50358 A.

**Ordnance.**

Ordnance Engineering as a Great Mechanical Industry. J. V. Meigs. A fully illustrated review of the present state of the art of ordnance engineering as one of the most highly developed mechanical industries. 4000 w. Engineering Magazine—October, 1902. No. 50784 B.

**Roller Bearings.**

The Essential Conditions of Sliding and Roller Bearings (Die Wesentlichen Eigenschaften der Gleit-und Rollenlager). Prof. R. Stribek. A comparison of the resistance of journal friction with the action of roller bearings; with diagrams showing the effect of various lubricants. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 6, 1902. No. 50712 D.

See Marine Engineering.

**Shells.**

The Drawing of Deep Shells from Sheet Metal. Joseph V. Woodworth. An illustrated article showing what has been accomplished. 600 w. Am Mach—Sept. 18, 1902. No. 50586.

**Turning.**

Time Required to Turn a Piece. Robert Grimshaw. Information concerning the time required to perform machine tool operations. 1000 w. Ir Trd Rev—Sept. 4, 1902. No. 50383.

**Works Management.**

See Industrial Economics.

## MATERIALS OF CONSTRUCTION.

**Beam Section.**

Broad Flanged I-Beams (Breitflanschige I-Träger). R. Cramer. A discussion of the advantages and manufacture of the beam of the section designed by Henry Grey, of Pittsburg, Pa., as made by the Differdingen works in Luxemburg. 1800 w. Zeitschr d Ver Deutscher Ing—Aug. 16, 1902. No. 50702 D.

**Cast Iron.**

Effect of Variations in the Constituents of Cast Iron. W. G. Scott. Read before the International Assn. of Test. Materials. Describing the influence of metalloids on cast iron as observed under practical conditions, without regard to theory. 7000 w. Foundry—Sept., 1902. No. 50323.

**Iron Protection.**

See Electrical Engineering, Electro-Chemistry.

**Lubricants.**

Cylinder Lubrication. J. S. V. Bickford. Reports of tests of oils for heat resisting properties, and of cylinder oils under steam conditions, etc. Ill. 3500 w. Horseless Age—Sept. 24, 1902. No. 50670.

**Masts.**

The Strength of Derrick Masts (Die Festigkeit von Lademasten). H. Sellentin. An analytical examination of the stresses upon the masts of hoisting derricks under various conditions of loading. Serial. Part I. 2000 w. Schiffbau—Aug. 23, 1902. No. 50775 D.

**Specifications.**

Discussion of Proposed Standard Specifications for Steel Forgings and Castings. Gus C. Henning. A critical discussion of the standard international specifications proposed. 4000 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50-682 C.

Specifications for Foundry Supplies. Gives specifications for foundry materials received from Mr. W. G. Scott of the Case Threshing Machine Co. 6700 w. Eng News—Sept. 11, 1902. No. 50503.

**Steel.**

Deterioration of Steel from Vibration. A discussion of this subject concluding that the deterioration under vibration is less potent than the use of faulty material. 2400 w. Engr, Lond—Sept. 19, 1902. No. 50812 A.

The Overheating of Mild Steel. E. Heyn. Read before the Iron and Steel Inst. An account of the writer's experiences regarding the brittleness produced in mild steel by overheating. The experiments refer only to mild steel such as is employed in boiler plates, structural material, wire, etc. 5000 w. Engng—Sept. 12, 1902. Serial. 1st part. No. 50638 A.

**Test Bars.**

Test Bars—Some Foundation for Comparisons. Asa W. Whitney. Remarks on certain relations to be considered as applying to various cast sections and test bars. 1500 w. Foundry—Sept., 1902. No. 50324.

**Tool Steel.**

The Recent Development of Tool Steel. Edmund L. French. Extract from a paper read before the Am. Assn. for the Adv. of Science. Discusses the advancement made in the production of "special steels." 1400 w. Eng News—Sept. 25, 1902. No. 50674.

## MEASUREMENT.

**Calorimeter.**

The Respiration Calorimeter. Description of machines for measuring and recording the changes in air supplied to living beings, including temperature, chemical composition, etc. 2000 w. Am Mach—Sept. 11, 1902. No. 50500.

**Journal Friction.**

Testing Apparatus for Lubricants and Bearing Metals (Ueber einen Apparat zur Untersuchung von Lagerölen und Lagermetallen). G. Dettmar. An electrically driven apparatus, enabling the friction of jourals to be determined for high rotative speeds, for various lubricants and bearing metals. 4000 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50756 B.

**Metric System.**

The Metric System of Weights and Measures. A copy of the circular sent announcing the purposes of a special meeting for the discussion of the metric system, with proceedings of the meeting. 1700 w. Jour W Soc of Engrs—Aug., 1902. No. 50285 D.

**Standards.**

The National Bureau of Standards. Prof. S. W. Stratton. Historical review of what has been done by the U. S. Congress, and discussion favoring the compulsory use of the metric system. 8000 w. Jour W Soc of Engrs—Aug., 1902. No. 50284 D.

## POWER AND TRANSMISSION.

**Compressed Air.**

Abuse in the Use of Compressed Air. W. L. Saunders. Calling attention to the unhealthfulness of discharged compressed air when impregnated with bad oils, and suggesting remedies. 1400 w. Compressed Air—Sept., 1902. No. 50484.

Comparison of Costs of Compressing Air with Steam and Electricity at Rossland, B. C. William Thompson. Read before the Canadian Mining Inst. Describes the steam plant erected for the Le Roi Mining Co., and the electric plant erected by the Rossland Great Western Mines, Limited, comparing their economy and relative efficiency. 2200 w. Can Min Rev—Aug. 30, 1902. No. 50296 B.

Compressed Air Calculations. W. C. Popplewell. The first of a series of articles discussing how the necessary calculations are to be made. 1700 w. Mech Engr—Aug. 23, 1902. Serial. 1st part. No. 50336 A.

Quadruplex Two-Stage Air Compressors. Illustrated detailed description of the Reavell air compressor. 2000 w. Engr, Lond—Aug. 22, 1902. No. 50363 A.

**Elevator Safeties.**

Elevator Safety Governors. William Baxter, Jr. Illustrates and describes a safety governor mounted directly upon the elevator car, and driven by a stationary rope which is secured to the top and bottom of the elevator well. Also shows a balanced governor. 1400 w. Am Mach—Sept. 18, 1902. No. 50584.

Improved Safety Catch for Elevators (Neue Fangvorrichtung an Fahrkörben). W. Schrader. Describing a new wedge device for supporting the cage of a lift in case of breakage of the hoisting cables. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 16, 1902. No. 50703 D.

**Linkage.**

The Construction of the Pole Paths and Normals of a Linked Quadrilateral (Konstruktion der Normalen und der Krümmungskreise der Polbahnen der Vierzylinderkette). W. Hartmann. A kinematic analysis of the movements of the joints of a quadrilateral linkage, by the method of instantaneous centres. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 6, 1902. No. 50713 D.

**Power Plant.**

The Power Plant of the Stecher Lithographic Company, Rochester, N. Y. Illustrated description of the lighting, heating and ventilating installation in a 2-story, 146 x225-ft. building. 2000 w. Eng Rec—Sept. 27, 1902. No. 50825.

## SPECIAL MOTORS.

**Alcohol.**

Motors, Boats and Automobiles Operated by Alcohol (Les Moteurs, les Automobiles et les Bateaux à Alcool). M. Ringelmann. A description of the testing plant by use of which the efficiency of the internal-combustion motors using alcohol as fuel can be found. 3500 w. Bull Soc d'Encour—Aug. 31, 1902. No. 50733 G.

**Diesel Motor.**

Test of a Diesel Oil Engine. H. Ade Clark. Describes an interesting test made by the writer, giving tabulated results. Ill. 2000 w. Engr, Lond—Aug. 22, 1902. No. 50366 A.

**Gas Engines.**

A New 2,300-H. P. Gas Engine Installation for High-Pressure Fire Service in Philadelphia. Illustrated description of engines for the new fire station. 1200 w. Eng News—Aug. 28, 1902. No. 50268.

Cylinder Charge Firing. Hugh Dolnar. Considers the electric spark charge firing the best, and explains the action of the three forms,—"wipe," "manner" and "jump" sparks. 3000 w. Autocar—Aug. 30, 1902. No. 50454 A.

Recent Developments in the Gas Engine. Prof. T. Hudson Beare. Extracts from a lecture delivered to the Graduates' Sec. of the Inst. of Mech. Engrs., England. On the use of blast-furnace waste gases, their heating value, etc. 3500 w. Ir Trd Rev—Sept. 18, 1902. No. 50582.

Recent Progress in Large Gas Engines. Herbert A. Humphrey. Read at Belfast meeting of the British Assn. Remarks on the progress with illustrated descriptions of various types. 3000 w. Engng—Sept. 19, 1902. Serial. 1st part. No. 50816 A.

The Internal Combustion Engine. Ed. C. de Segundo. On the future outlook for this class of engines. 1200 w. Elec Rev, Lond—Aug. 29, 1902. No. 50461 A.

The Selection of Gas Engines. J. D. Lyon. Brieflv considers points that should be taken into account in the selection. 1500 w. Eng Rec—Sept. 6, 1902. No. 50451.

**Gasoline.**

Various Applications of the Gasoline Motor. Gives illustrations with brief descriptions of a number of applications. 1200 w. Sci Am—Sept. 13, 1902. No. 50488.

**Gas Power.**

Blast Furnace Gas Power. Horace Allen. Discusses this gas as an important source of cheap power. 2500 w. Elec Rev, Lond—Sept. 12, 1902. No. 50623 A.

Generator Gas Plant for Electric Driving (Generatorgas-Anlagen für den Betrieb von Elektricitätswerken). Fr. Ross. Describing especially the installations at Pressburg, Erlangen, and elsewhere in Austria, using water gas in gas engines for driving dynamos. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 15, 1902. No. 50728 B.

Utilization of Blast Furnace Gas in Gas Engines at the Ilseder Works (Ver werthung der Hochofengase in Gasmaschinen auf der Ilseder Hütte). F. W. Lürmann. Describing a plant in which two engines of 1000 h. p. each driving dynamos and one blowing engine of 600 h. p. are operated by furnace gas, at Ilsenberg, in the Harz. 1200 w. Stahl & Eisen—Aug. 15, 1902. No. 50750 D.

**Ignition.**

Gas Engine Ignition by Contact or Catalytic Action. Dr. Paul Gans de Fabrice, in *La Locomotion.* Reviews attempts made to utilize the catalytic properties of platinum for ignition in explosive motors, and describes the electro-catalytic sparking plug invented by the writer. 1500 w. Sci Am Sup—Sept. 13, 1902. No. 50491.

Guillon Igniter for Explosion Motors. Illustrated description of an ignition appliance invented by M. Henri Guillon. 1200 w. Prac Engr—Sept. 5, 1902. No. 50558 A.

**Internal Combustion Motors.**

See Mechanical Engineering, Automobiles.

**Oil Motors.**

See Marine Engineering.

## STEAM ENGINEERING.

**Chimney Stability.**

The Statical Computations for the Stability of a Chimney (Beiträge zur Statischen Untersuchung von Schornsteinen). A mathematical investigation of the stabilty of masonry chimneys by M. Preuss and G. Lang, discussing the accuracy of the formula of Müller-Breslau, and the tables based upon it. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 30, 1902. No. 50710 D.

**Engine Erection.**

The Erection of High-Speed Center-Crank Engines. H. V. Hunt and C. G. Robbins. Aims to give clear and concise directions for the erection of a high-speed center crank engine. Ill. 2800 w. Power—Sept., 1902. No. 50258 C.

**Engine Tests.**

English and American Engines for Glasgow Tramways. A copy of the figures obtained by Prof. Barr when making his official tests on the Pinkston engines, with brief remarks. 500 w. Elec Rev, Lond—Sept. 12, 1902. No. 50617 A.

**Flue Gases.**

Reclaiming Waste Heat from Flue Gases. C. G. Robbins. Illustrates and describes a typical economizer, also an arrangement for preheating the air before admitting it to the fire, discussing both systems. 2200 w. Engr, U S A—Sept. 15, 1902. No. 50665.

**Fly-Wheels.**

Speed for Fly-Wheels. W. H. Boehm. How to determine the speed at which disrupture will occur. 800 w. Ir & Coal Trds Rev—Aug. 29, 1902. No. 50469 A.

**Oil Fuel.**

Petroleum as Fuel. William Kent. A study of the practical relative values of petroleum and coal. 4500 w. Power—Sept., 1902. No. 50259 C.

See Marine Engineering.

**Power Plant.**

The Steam Plant of the Carpenter Steel Company, Reading, Pa. Illustrates and describes a 1200 h. p. plant. 1500 w. Eng Rec—Sept. 6, 1902. No. 50445.

**Pumping Engines.**

See Mechanical Engineering, Hydraulics.

**Rolling Mills.**

Steam Generation for Large Rolling Mills. J. R. Bibbins. An illustrated description of a boiler plant embodying novel constructive features recently installed for the Lukens Iron & Steel Co., Coatesville, Pa. 2200 w. Ir Age—Sept. 25, 1902. No. 50666.

**Smoke.**

The Treatment of Smoke. W. N. Shaw. Lecture before the Sanitary Inst. (England). Discussing the problem of smoke abatement and suggesting the erection of municipal chimneys, or orifices for the delivery of the smoke of a number of chimneys, and thus making it possible to deprive the smoke of its soot. 3000 w. Archt, Lond—Sept. 12, 1902. Serial. 1st part. No. 50606 A.

**Speed Regulation.**

The Regulation of Steam Engines (Der Reguliervorgang bei Dampfmaschinen). Dr. B. Rülf. A graphical and mathematical analysis of the conditions affecting the speed variations of reciprocating engines, and the action of regulating devices. Two articles. 5500 w. Zeitschr d Ver Deutscher Ing—Aug. 30, Sept. 13, 1902. No. 50709 each D.

See Electrical Engineering, Generating Stations.

**Steam Engines.**

A Rolling Mill Engine of 6000 H. P. Illustrated detailed description of a very large and powerful steam engine for a rolling mill in Youngstown, O. 2000 w. Eng News—Aug. 28, 1902. No. 50266.

A Wonderful Old-Time Engine in Scotland; Still Working After Sixty Years' Constant Service. Benjamin Taylor. An illustrated description and historical account of a standing engine for hauling trains up an incline at Glasgow, on the North British Railway. 1100 w. Power—Sept., 1902. No. 50256 C.

English and American Engines for the Glasgow Tramways. An editorial severely criticizing the Allis engines, and the reports concerning them which have appeared in the British and American papers. 2400 w. Elec Rev, Lond—Aug. 29, 1902. No. 50459 A.

Some Considerations Affecting the Economy of Marine Screw Engines. E. Hall-Brown. Discussion of this paper which was read before the Inst. of Engrs. & Shipbuilders in Scotland. 3 plates. 7500 w. Trans of Inst of Engrs & Shipbldrs in Scotland—Aug., 1902. No. 50338 D.

The Engines of the Glasgow Tramways. Editorial Comment on the engines furnished by the three firms and their trials. 1600 w. Engng—Aug. 22, 1902. No. 50-372 A.

The Glasgow Tramway Engines. Editorial reviewing the leading points in the story of the two types of main engines and their tests. 3300 w. Engng—Sept. 12, 1902. No. 50636 A.

Steam Consumption and Maximum Horse-Power. Discusses the requirements in the specifications of condensing engines. 1100 w. Power—Sept., 1902. No. 50257 C.

**Steam Turbines.**

Tests of Steam Turbine Installed at Hartford, Conn. Prof. William Lispenard Robb. A summary of the tests made by the writer to determine the efficiency that would be obtained under the actual operating conditions at Hartford. 800 w. Elec Wld & Engr—Sept. 6, 1902. No. 50442.

**Superheaters.**

Some Notes on the Construction and Operation of Flue-Fired Superheaters. H. Cruse. Considers the construction, materials and management of superheaters. 2400 w. Elec Times—Aug. 21, 1902. No. 50335 A.

**Surface Condensers.**

A Rational Determination of the Dimensions of Surface Condensers (Determinazione Razionale delle Dimensione Principali dei Condensatori a Superficie). Natale Matteucci. A review of the existing formulas and the development of new rules based on the actual heat exchanges. Rivista Marittima—Aug.-Sept., 1902. No. 50774 H.

**Valve Gears.**

Speed of Engines Fitted with Trip Valve Gear. Abstract of the individual replies to inquiries as to the speeds used by a number of engine builders for Corliss engines fitted with trip or releasing valve gear. 2500 w. Engr, Lond—Aug. 29, 1902. No. 50475 A.

### MISCELLANY.

**Aeronautics.**

The Development of the Air-Ship. John M. Bacon. An interesting review of attempts to navigate the air dating back hundreds of years, and considering the outlook hopeful. 4500 w. Nineteenth Cent—Sept., 1902. No. 50604 D.

**Alcohol.**

Lighting and Heating by Alcohol (L'Eclairage et le Chauffage par l'Alcool). M. Lindet. Describing especially the various forms of lamps in which an incandescent mantle is heated by alcohol for the production of light. 10,000 w. Bull Soc d'Encour—Aug. 31, 1902. No. 50732 G.

**Composing Machine.**

The Meray-Rozar Electrotypographic Machine. An illustrated description of this composing machine and its operation. 1000 w. Sci Am Sup—Aug. 30, 1902. No. 50245.

**Düsseldorf Exposition.**

Machinery for the Textile Industries (Die Arbeitsmaschinen für die Textilindustrie). G. Rohn. The first of a series of illustrated papers describing the textile machinery exhibited at Düsseldorf, 1902. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 30, 1902. No. 50708 D.

**Hose.**

Manufacture of Rubber Hose. Charles Dunn. Describes one method of manufacturing air and steam hose. 1100 w. Loc Engng—Sept., 1902. No. 50418 C.

**Hot-Water Heating.**

Hot Water Heating for Domestic Service. H. C. Lincoln. An illustrated outline of the different systems in common use, with a few rules for the design of such systems. 2500 w. Steam Engng—Sept. 10, 1902. No. 50561.

The Reck System of Heating by Hot Water (Die Warmwasserheizung von Reck). H. Fischer. Describing a combination of a hot water heater with a steam boiler for house heating. 1200 w. Zeitschr d Ver Deutscher Ing—Sept. 6, 1902. No. 50714 D.

**Lighting.**

The Development of Lighting and Heating (Neuerungen auf dem Gebiete des Beleuchtungs- und Beheizungswesens). Franz Walter. The first of a series of articles of a historical character; this instalment describes early gas works in Vienna. Serial. Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 5, 1902. No. 50731 B.

**Mechanical Engineers.**

The Mechanical Engineer a Factor in Modern Mining, Milling and Smelting. C. H. Repath. Read at the Butte meeting of the Min. Cong. A resume of smelting operations in Montana, and the part taken by the mechanical engineer. 5800 w. Min & Sci Pr—Sept. 13, 1902. No. 50596.

**Mechanical Plant.**

The Mechanical Plant in a Newark, N. J., Department Store. Illustrates and describes the interesting plant installed in the store of Hahne Bros. 1700 w. Eng Rec—Aug. 30, 1902. No. 50319.

**Sand Blast.**

Sand Blast Machines (Les Machines à Jet de Sable). A. de Riva-Berni. Illustrating a number of devices for utilizing the abrading action of the sand blast in the arts. 2500 w. 1 plate. Génie Civil—Sept. 6, 1902. No. 50727 D.

**Schoolhouse.**

Ventilating and Heating No. 23 School, Rochester, N. Y. Illustrated description of a 22-room school with a fan system of ventilation and direct steam radiation. 2200 w. Eng Rec—Sept. 20, 1902. No. 50647.

**Wood-Working Tools.**

A Study of Wood-Working Machinery (Etude sur les Machines-Outils Utilisées dans le Travail de Bois). Paul Razous. A comprehensive study of wood working machinery, with numerous illustrations. The first article treats of sawing machines. Serial. Part I. 5000 w. Revue de Mécanique—Aug. 31, 1902. No. 50736 E+F.

## MINING AND METALLURGY

### COAL AND COKE.

**Breaker.**

The Auchincloss Breaker. George L. Carlisle, Jr. An illustrated description of the novel methods employed in construction, and in arrangement and driving of the machinery of this breaker at Nanticoke, Pa. 2800 w. Mines & Min—Sept., 1902. No. 50514 C.

**British Columbia.**

A Description of the Mining Operations, Pumping and Hauling Plant, etc., at the Comox Colliery. Jno. Matthews. 1800 w. B C Min Rec—Sept., 1902. No. 50498 B.

**Cape Colony.**

The Indwe Coal Mines, Cape Colony. A description of these mines which produce nearly 70 per cent. of the total coal mined in Cape Colony. Ill. 3300 w. Col Guard—Aug. 29, 1902. Serial. 1st part. No. 50467 A.

**Coal Cutting.**

See Electrical Engineering, Power Applications.

**Colliery Developments.**

Extensive Colliery Developments at Bathgate. Describes and illustrates the extensive work of the last ten years, the character of the coal, the equipment of the mines, etc. 2500 w. Col Guard—Aug. 22, 1902. No. 50359 A.

**Disaster.**

The Mount Kembla Disaster. An account of a terrible explosion in a colliery in New South Wales in which eighty-seven lives were lost. Also editorial. 2800 w. Aust Min Stand—Aug. 7, 1902. No. 50608 B.

**Flat Coal Beds.**

The Economic Theory of Shafts and Slopes for Flat Coal Beds. E. Brackett. A discussion of the economical means of raising the loaded mine cars for the purpose of screening the coal. 2400 w. Eng & Min Jour—Sept. 20, 1902. Serial. 1st part. No. 50650.

**Lignite.**

Power from Lignite in Germany. An account of large works in Germany where lignite is the only fuel used for steam-raising purposes. 700 w. Engr, Lond—Sept. 5, 1902. No. 50566 A.

**Machines.**

Pick and Chain Machines. L. J. Daft. A comparison of the two types from the standpoint of an advocate of pick machines. 3300 w. Mines & Min—Sept., 1902. No. 50510 C.

**Pillars.**

The Spacing of Pillars in the Brown-Coal Measures of Northwestern Bohemia (Schutzpfeilerbreite bei der Auskohlung des Braunkohlenflötzes in dem Nordwestböhmischen Becken). K. Balling. Giving the method of computing the pressures and the dimensions and spacing of pillars to sustain the roof with a minimum loss of coal. Serial. Part I. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 6, 1902. No. 50739 B.

**Shop Records.**

See Industrial Economics.

**South Africa.**

The Coal and Coalfields of South Africa. Information obtained from official sources. 5000 w. Col Guard—Sept. 19, 1902. No. 50810 A.

**Turkey.**

The Mineral Resources of Turkey—Coal. J. E. Spurr. Information concerning the deposits and their character. 1800 w. Engng & Min Jour—Sept. 6, 1902. No. 50424.

**Washing Plant.**

Coal-Washing Plant at Bathgate. Illustrated particulars of the plant at the Mosside Colliery. 2000 w. Col Guard—Sept. 5, 1902. No. 50564 A.

The Eastern Coal and Coke Company's Washer at Cokedale, Kan. W. R. Crane. Illustrated detailed description. 1600 w. Eng & Min Jour—Sept. 20, 1902. No. 50-649.

**Westphalia.**

The Development of the Rhenish-Westphalian Coal District during the Past Century (Entwicklung der Rhenisch-Westfälischen Kohlenerzeugung während des Verflossenden Jahrhunderts). B. Schulz-Briesen. With a graphical diagram showing the great development from 1821 to 1900. 600 w. 1 plate. Glückauf—Aug. 23, 1902. No. 50741 B.

## COPPER.

**Leaching.**

The Neill Leaching Process for Copper Ores. J. H. Burfeind. Describes this process, giving information concerning the cost, a statement of advantages claimed, etc. 3000 w. Min Rept—Sept. 11, 1902. No. 50528.

**Smelting.**

Metallurgical Practice at the Greenwood Smelter. Paul Johnson. From the report of the Minister of Mines, giving an account of work at the B. C. Copper Co.'s smelter. 1800 w. B C Min Rec—Sept., 1902. No. 50499 B.

## GOLD AND SILVER.

**Cyaniding.**

The Direct Cyaniding of Wet-Crushed Ores in New Zealand. Hamilton Wingate. Gives particulars of experimental trials carried out on a working scale at the Waite-Kauri Extended mine, giving results and conclusions. 3800 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 50684 C.

**Deep-Level Mining.**

Deep-Level Mining at the Thames. Abstracts from a memorandum of the government geologist of New Zealand. Describes the geology of the region, and considers points that need to be determined in connection with deep-sinking at this place, showing the possibility of workable gold at deep levels, and discussing how to reach it. 4500 w. N Z Mines Rec—July 16, 1902. No. 50342 B.

The Borehole at the Thames. F. B. Allen. Describes the material brought up from the borehole to test the deep ground of this district of New Zealand. 1100 w. N Z Mines Rec—July 16, 1902. No. 50343 B.

**Georgia.**

Gold Mining in McDuffie County, Georgia. W. H. Fluker. An account of the discovery of gold in this region and of the development. 2800 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50680 C.

**Gold Production.**

The Gold Production of North America: Its Geological Derivation and Probable Future. Waldemar Lindgren. Portions of a paper read at the Butte, (Mont.) meeting of the Mining Congress. Interesting information concerning the geology of the gold deposits. 2500 w. Eng News—Sept. 18, 1902. No. 50587.

**Idaho.**

Facts About Thunder Mountain. Robert Bell. Illustrated description of this district. The most interesting features are the character of the gold deposits of the Dewy Mine, and the great development of acedic lavas. 3500 w. Eng & Min Jour—Aug. 30, 1902. No. 50307.

**Kalgoorlie.**

See Electrical Engineering, Power Applications.

**Ontario.**

Silver Mining in Ontario. An account of an important consolidation of some of the mines of Lake Superior, with notes on their past history. Ill. 3200 w. Can Min Rev—Aug. 30, 1902. No. 50295 B.

**Quartz Mining.**

A New and Promising Free-Milling Quartz Territory. J. F. Musselman. An illustrated article giving information and setting forth the advantages of the Fish River Camp, B. C., which is principally a producer of free-milling gold ore. 3000 w. B C Min Rec—Sept., 1902. No. 50497 B.

**Slimes.**

Electrical Treatment of Slimes. F. T. Mumford. Read before the Aust. Inst. of Min. Engrs. The advantages to be gained by the electrical precipitation on mercury, describing the process. 2500 w. Aust Min Stand—July 24, 1902. No. 50334 B.

The Desulphurization of Slimes. E. J. Horwood. Read before the Aust. Inst. of Min. Engrs. On the advantages of heap roasting, and the method. 2800 w. Aust Min Stand—July 24, 1902. No. 50332 B.

**Smelting.**

Inauguration of the Smelting Industry on Vancouver Island, British Columbia. William M. Brewer. An illustrated description of the plant recently put in operation, giving reasons for believing the plant to be advantageously located. 2400 w. Eng & Min Jour—Sept. 6, 1902. No. 50425.

## IRON AND STEEL.

**Armor.**

Armor Plate at the Düsseldorf Exposition, 1902 (Der Panzer auf der Düsseldorfer Austellung 1902). J. Castner. A review of the exhibits at Düsseldorf, with data concerning recent trials of armor plate, by Krupp. 3000 w. Stahl und Eisen—Sept. 1, 1902. No. 50754 D.

Armor-Plate Exhibits at the Düsseldorf Exposition (Les Blindages a l'Exposition de Düsseldorf). L. Baclé. Discussing the exhibits, and giving a tabular view of the results of recent armor-plate tests. 2500 w. Génie Civil—Aug. 23, 1902. No. 50722 D.

Recent Trials of Armor Plates of Cemented Steel (Essais Récemment Pratiqués sur les Plaques en Acier Cémenté). L. Baclé. An account of recent tests in England and America upon surface hardened plates, including those with the Gathmann gun. 2500 w. Génie Civil—Aug. 30, 1902. No. 50724 D.

**Blast Furnaces.**

The Belgian-Ougree Blast Furnaces and Steel Works and Modern Electrically-Operated Plant. Frank C. Perkins. An illustrated article describing the electric power plant. The waste gases from the blast furnaces are utilized at a central power plant and the energy transmitted electrically for about three-quarters of a mile. 2500 w. Sci Am Sup—Sept. 27, 1902. No. 50809.

The Designing and Equipment of Blast Furnaces. Jno. L. Stevenson. The first of a series of papers aiming to set forth the practice and necessary methods, to arrive at the right size, shape, and proportions of any furnace adapted and suitable for the work it is intended to perform. Ill. 1800 w. Engr, Lond—Sept. 12, 1902. Serial. 1st part. No. 50629 A.

**Blowing Engines.**

Blast Furnace Blowing Engines at Donawitz Works, Austria (Hochofengebläse des Hüttenwerkes Danowitz). Description and illustrations of double vertical blowing engine delivering 1000 cubic metres of air per minute at a pressure of 0.7 atmosphere. 1000 w. Zeitschr d Ver Deutscher Ing—Aug. 23, 1902. No. 50704 D.

**Düsseldorf Exhibition.**

Iron and Steel at the Düsseldorf Exhibition, 1902. Prof. Hermann Wedding. Read at meeting of the Iron & Steel Inst. A review of the extensive display of the metallurgy of iron and machine construction. 3200 w. Engng—Sept. 5, 1902. No. 50574 A.

**Electric Smelting.**

See Electrical Engineering, Electro-Chemistry.

**Germany.**

Twenty Years of the German Iron and Steel Industries. J. Stephen Jeans. A review of the progress of the various branches of the iron trade of the empire since 1880. Charts. 4500 w. Ir & Coal Trds Rev—Aug. 29, 1902. No. 50468 A.

**Heat Treatment.**

The Influence of Heating and Annealing upon the Resistance of Iron and Steel (Der Einfluss des Glühens und Abschreckens auf die Zugfestigkeit von Eisen und Stahl). A collection of the researches of Brinell, edited by Axel Wahlberg, discussing experiments made at the Fagersta Works, Sweden. 2500 w. Stahl und Eisen—Aug. 15, 1902. No. 50749 D.

**Iron Works.**

The Works of the Skinningrove Iron Company. Illustrated detailed description of this plant which has recently been thoroughly remodeled, and is considered one of the finest of its kind in Great Britain. 3500 w. Ir & Coal Trds Rev—Sept. 12, 1902. No. 50628 A.

**Open Hearth.**

A German Plate Mill and Open-Hearth Plant. From *Stahl und Eisen.* An illustrated account of the plate mill and open-hearth plant of the Rendsburg Steel and Rolling Mill. 1500 w. Ir Trd Rev—Sept. 11, 1902. No. 50485.

**Pig Iron.**

The Progress and Manufacture of Pig Iron in Germany since 1888. W. Brugmann. Read at meeting of the Iron & Steel Inst. The present article discusses the economic aspect of the industry, the development, the localities, etc. 5300 w. Engng—Sept. 5, 1902. Serial. 1st part. No. 50575 A.

**Progress.**

Progress in Steel Works Practice in Germany since 1880. R. M. Daelen. Read at meeting of the Iron & Steel Inst. An account of the recent progress and the improvements which have been effected. 3800 w. Engng—Sept. 5, 1902. No. 50576 A.

**Steel Works.**

The Rheinische Steel Works. Describes these works as typical of the very best modern German practice. 3000 w. Engr, Lond—Sept. 19, 1902. No. 50813 A.

The Steel-Plant at Monterey, Mexico. William White, Jr. Describes the deposits and gives plan and description of the plant. 2500 w. Trans Am Inst of Min Engrs—Nov, 1901. No. 50679 C.

## MINING.

**Accident.**

Another Accident Caused by Oiling Machinery While in Motion. Describes a frightful accident at Beaumont, Otago, on a dredge which the engineer was oiling. 1200 w. N Z Mines Rec—July 16, 1902. No. 50344 B.

**Blasting.**

Remarkable Blasting Operations in Slate Quarries. Describes interesting blasting operations in Wales. Ill. 900 w. Sci Am—Sept. 6, 1902. No. 50404.

**British Columbia.**

Mining Industry and Mineral Resources of British Columbia. W. M. Brewer. Mr. Brewer's second paper gives a general survey of the mainland districts, including deposits of gold, copper and silver-lead. 4500 w. Engineering Magazine—October, 1902. No. 50785 B.

Notes on the Geology and a Few Ore Deposits of South Eastern British Columbia. C. V. Corless. Notes which seem to indicate that the ore bodies treated of form part of a related group. 9000 w. Can Min Rev—Aug. 30, 1902. No. 50298 B.

**Colorado.**

South Park, Colorado. Prof. Arthur Lakes. An illustrated description of its geology and economic resources in gold, silver, lead, coal and oil. 1800 w. Mines & Min—Sept., 1902. No. 50513 C.

**Concentration.**

The Concentration of Ores by Oil. Illustrated description of an Elmore plant for this work. 900 w. Engr, Lond—Aug. 27, 1902. No. 50476 A.

**Düsseldorf Exposition.**

Mining Plant and Machinery (Die Bergbaulichen Anlagen). The first of a series of articles describing the mining exhibits at Düsseldorf, 1902. Two articles. 5000 w. Glasers Annalen—Aug. 15, Sept. 1, 1902. No. 50716 each D.

**Explosives.**

Mining Explosives. A. W. Warwick. Considers the effect of perfect and imperfect detonation, proper strength of caps for different conditions, etc. 2500 w. Mines & Min—Sept., 1902. No. 50512 C.

**Firedamp.**

The Investigation of Firedamp (Beiträge zur Untersuchung der Grubenwetter). F. Schrieber. A description of the Broockmann-Schondorff apparatus for the analysis of mine gases. 1200 w. Glückauf—Aug. 30, 1902. No. 50743 B.

**First Aid.**

First Aid to the Injured in Mining. Dr. George W. King. Abstract of a paper read before the International Min. Cong. A discussion of the causes of accidents and the methods of rescuing and aiding the injured. 3300 w. Engr & Min Jour—Sept. 13, 1902. No. 50543.

**Geology.**

Application of Geology to Mining. J. E. Spurr. Read at the Butte meeting of the Min. Cong. On the assistance of each to the other and the advantage of working together. 2500 w. Min & Sci Pr—Sept. 13, 1902. No. 50597.

**Igneous Rocks.**

Crystalline Structure of Igneous Rocks. Thomas Andrews. Briefly considers the primary formation of igneous rocks, reproducing typical samples showing the crystalline structure, and describing the main groups. Ill. 900 w. Engng—Sept. 5, 1902. No. 50569 A.

**Japan.**

Mining in Japan. Fritz J. Frank. An illustrated description of the mines and plants of the Hokkaido Tanko Tetsudo Kaisha. 2200 w. Mines & Min—Sept., 1902. No. 50509 C.

**Mine Drainage.**

The Drainage Plant of the Horcajo Mines (Installation d'Exhaure des Mines de l'Horcajo). Describing the system of high-pressure centrifugal pumps arranged in series, for draining the silver-lead mines of Horcajo, Spain. 2500 w. Génie Civil —Aug. 16, 1902. No. 50720 D.

**Mining Cartridge.**

The Hydraulic Mining Cartridge. James Tonge, Jr. Awarded the Benjamin Shaw prize for industrial hygiene. A description of an appliance for breaking down coal in mines without the use of explosives, and of the mode of working. 2000 w. Jour Soc of Arts—Sept. 5, 1902. No. 50553 A.

**Mining Law.**

Senator Kearns's New Mining Law. R. W. Raymond. Discussion of a bill to come before the U. S. Congress at the next session. 1700 w. Eng & Min Jour—Sept. 6, 1902. No. 50422.

**Output.**

Recording the Output of a Mine. Charles V. Jenkins. Describes a system of securing detailed record of ore production, distinguishing shipments, and identifying returns. 4200 w. Mines & Min—Sept., 1902. No. 50511 C.

**Ore Handling.**

Hoover & Mason Ore Handling Plant at South Chicago, Ill. Illustrates and describes the ore-unloading plant at the South Chicago works of the Illinois Steel Company. 2500 w. Ir Trd Rev—Sept. 4, 1902. No. 50381.

See Electrical Engineering, Power Applications.

**Rock Drills.**

The Progress of Rock Drilling in 1902 (Die Gesteinbohrmaschinenfrage im Jahre 1902). Th. Giller. A comparison of the relative advantages of compressed air and electricity, showing that the best results are to be expected from their combination 3000 w. Glückauf—Aug. 30, 1902. No. 50742 B.

**Safety Brake.**

The Blosfeld Safety Brake for Winding Engines. Hr. Ansorge, in *Zeitschrift für Berg-, Hütten-, und Salinenwesen.* Illustrates and describes a brake intended to supplement the ordinary brake in an emergency. 1200 w. Col Guard—Sept. 19, 1902. No. 50811 A.

**Shaft Sinking.**

A New System of Sinking Shafts. Illustrates and describes a method suited to all kinds of soil, devised by the Hardy Patent Pick Co., of Sheffield, England. It claims speed of boring, and immunity from accident. 900 w. Sci Am—Sept. 6, 1902. No. 50403.

Steel Lining Mine at "B" Shaft, Pioneer Mine, Minnesota. Frank Drake. Read at meeting of Lake Superior Mining Inst. Abstract of a paper on the use of steel in lining mine shafts. Ill. 2200 w. Eng & Min Jour—Sept. 13. 1902. No. 50542.

**Slate.**

The Underground Slate Workings of France. Illustrates and describes methods of operating at Angers and at Ardennes, and gives information from a recent work by Mr. Watrin, Chief Inspector of Mines at Mézières. 2000 w. Stone—June, 1902. No. 50479 C.

**Transvaal.**

The New Deep-Level Mines in the Transvaal. Notes from the special commissioner of the London *Economist.* Considers some questions involved in working the deep ground. 1200 w. Eng & Min Jour—Sept. 20, 1902. No. 50651.

**Witwatersrand.**

The Preservation of Life in the Witwatersrand Mines. T. Lane Carter. States the causes of the mortality and suggests remedies. 1500 w. Eng & Min Jour—Aug. 30, 1902. No. 50309.

## MISCELLANY.

**Aluminum.**

Aluminum. The first of a series of articles on its history and metallurgy. 1800 w. Aust Min Stand—July 24, 1902. Serial. 1st part. No. 50333 B.

Contributions to the Study of the Alloys of Aluminum (Contributions à l'Étude des Alliages d'Aluminum). Léon Guillet. Discussing alloys with tungsten, molybdenum, copper, tin, titanium, iron, manganese, nickel, etc., and their chemical and physical properties. 15000 w. Bull Soc d'Encour—Aug 31, 1902. No. 50734 G.

See Electrical Engineering, Electro-Chemistry.

**Arsenic.**

The Recovery of Aresnic from Ores and Metallurgical By-Products. Herbert Haas. Illustrated description of a roasting furnace and its operation. 1000 w. Mining & Sci Pr—Sept. 6, 1902. No. 50495.

**Dusseldorf Exposition.**

Metallurgy at the Düsseldorf Exposition, 1902 (Der Bergbau auf der Düsseldorfer Austellung 1902). H. Beckert. A review of the iron working exhibits, products, and methods shown at the Düsseldorf exposition. Two articles. 1 plate. 6000 w. Glückauf—Aug. 16, 23, 1902. No. 50740 each B.

**Gypsum.**

Present and Future of the American Gypsum Industry. Frank A. Wilder. An illustrated article stating the localities in the United States where it is found, the causes of the deposits, the uses, etc. 3000 w. Eng & Min Jour—Aug. 30, 1902. No. 50308.

**Nickel.**

The Sulphide Ore Bodies of the Sudbury Region. L. P. Silver. Describes these deposits which are the source of over forty-five per cent. of the present nickel production of the world. Ill. 5600 w. Can Min Rev—Aug. 30, 1902. No. 50297 B.

**Oil Fields.**

The Beaumont Oil Field, with Notes on Other Oil-Fields of the Texas Region. Robert T. Hill. Considers the geological interpretation of oil phenomena, describing the geography of this region, the geology, the different fields, composition of the oil, development, etc., offering an explanatory hypothesis. Ill. 15600 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50683 D.

**Petroleum.**

Diatom-Earth in Arizona. W. P. Blake. Describes these deposits, and discusses their origin and as a possible source of petroleum. 2800 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50685 C.

**Phosphate.**

The Phosphate-Rock Discovery in Otago. James Park. Describes the physical and geological features, the deposits, etc. 3500 w. N Z Mines Rec—Aug. 16, 1902. No. 50605 B.

**Precious Stones.**

How to Identify Precious Stones. Describes methods of testing. 2000 w. Min & Sci Pr—Aug. 23, 1902. No. 50239.

**Quarries.**

The Sandstone Quarries of Saxony and Silesia. An illustrated description of these quarries, methods of working, geology, etc. 3000 w. Quarry—Sept. 1, 1902. No. 50464 A.

**Quicksilver.**

The Cinnabar Deposits of the Big Bend Province of Texas. Robert T. Hill. Information concerning these deposits, especially their nature and geology. Map. 4000 w. Eng & Min Jour—Sept. 6, 1902. No. 50423.

**Turquoise.**

Turquoise Mining in Arizona and New Mexico. An illustrated article describing the deposits, the formation in which turquoise is found, methods of mining, etc. 1800 w. Min & Sci Pr—Aug. 23, 1902. No. 50240.

# RAILWAY ENGINEERING

## CONDUCTING TRANSPORTATION.

**Accidents.**

Train Accidents in the United States in July. Condensed record of the principal accidents. 3000 w. R R Gaz—Sept. 5, 1902. No. 50391.

Train Accidents in the United States in August. Condensed record with remarks. 4000 w. R R Gaz—Sept. 26, 1902. No. 50808.

**Employees.**

English and American Railroad Employees. Editorial discussion of the conditions affecting railroad transportation in the two countries. 2800 w. R R Gaz—Sept. 5, 1902. No. 50393.

**Rapid Transit.**

Shortening Time Across the Continent. Henry Herbert McClure. Discussing the improved railway service in the United States, especially the twenty-hour train established between New York and Chicago. 1800 w. Nat Geog Mag—Aug., 1902. No. 50289 C.

**Train Service.**

British and French Summer Train Services in 1902. Charles Rous-Marten. Reviewing what has been done during the current season in the way of improvements. 2000 w. Engr, Lond—Aug. 22, 1902. No. 50362 A.

## FINANCIAL.

**Railroad Capitalization.**

The Value of the Railroads and Their Capitalization. H. T. Newcomb, in the *Yale Review,* August. Some notes on capitalization statistics. 1400 w. R R Gaz—Aug. 29, 1902. No. 50274.

### MOTIVE POWER AND EQUIPMENT.

**Air Brakes.**

Proper Air Brake Instructions to All Concerned to Prevent the Ruination of Wheels by Skidding, and Handling of Air on Freight Trains. Abstract of a committee report to the Traveling Engineers' Assn. with brief discussion. 2000 w. Ry Age—Sept. 19, 1902. No. 50656.

**Axles.**

Graphical Method of Finding Limit Diameters for Car and Tender Axles. R. B. Kendig. Gives a diagram and explains its use. 800 w. Am Engr & R R Jour—Sept., 1902. No. 50412 C.

**Cars.**

90,000-Pounds Capacity Gondola Car. Illustrates and describes a car with steel draft frame and roller side bearings built for the L. S. & M. S. Ry. 300 w. Am Engr & R R Jour—Sept., 1902. No. 50408 C.

**Coal Car.**

50-Ton Steel Coal Car, with Westinghouse Friction Draft Gear; Pennsylvania R. R. Illustrates and describes the construction of these cars and compares them with some others of the same class built by the same firm for other railways. 1800 w. Eng News—Sept. 4, 1902. No. 50395.

**Headlights.**

Headlight with a Vertical Beam. Illustrates and describes a new type of electric headlight which in addition to sending a powerful ray along the tracks, also projects a vertical beam. 1200 w. Sci Am—Sept. 13, 1902. No. 50489.

**Locomotive Boilers.**

The Care and Management of the Locomotive Boiler. Thomas J. Rossell. On the advantages gained by keeping the boiler and flues clean, and concerning the rapidity with which the work may be done by devices invented by the writer. 900 w. Loc Engng—Sept., 1902. No. 50417 C.

**Locomotives.**

Atlantic Type Passenger Engines for the Chesapeake & Ohio. Illustrations and general dimensions. 250 w. R R Gaz—Sept. 12, 1902. No. 50516.

Baldwin Fast Freight Ten-Wheel Engine for the Northern Pacific. Illustrated description of a type of which forty have recently been ordered. 900 w. Loc Engng—Sept., 1902. No. 50415 C.

Express Compound Locomotive, Austrian State Railways. Illustration and description of the fine two-cylinder four-coupled locomotive employed for the fast international train services. 800 w. Engr, Lond—Sept. 12, 1902. No. 50630 A.

Goods Engine, Cape Government Railways. Illustrated description of a narrow-gauge locomotive, embodying the latest improvements on engines of this type. 900 w. Engr, Lond—Sept. 5 1902. No. 50568 A.

New Six-Coupled Passenger Locomotives. Gives general plans of two new engines of this type, one for the C. & O. Ry. and the other for the M. P. Ry. Comparisons may be made by aid of the drawings and information given. 800 w. Am Engr & R R Jour—Sept., 1902. No. 50410 C.

Passenger Locomotives for the National Railroad of Mexico. General description with illustrations. 500 w. R R Gaz—Aug. 29, 1902. No. 50275.

Six-Wheeled Coupled Passenger Locomotive; Caledonian Railway. Illustrated description of a locomotive designed for heavy gradients and sharp curves. 400 w. Engng—Aug. 29, 1902. No. 50470 A.

Some New Engines for the Chicago and Alton. Gives erecting card and principal dimensions of simple consolidation engines. 600 w. R R Gaz—Sept. 5, 1902. No. 50392.

Tandem Compound Consolidation Locomotives for the Erie R. R. Half-tone engraving, elevation, and sectional views, with description. 1000 w. Ry & Engng Rev—Aug. 30, 1902. No. 50294.

Tank Locomotive for Suburban Traffic, Northern Railway of France. Illustrated description of a new type of tank locomotive for service between Paris and towns within 50 miles. 500 w. Engng—Sept. 12, 1902. No. 50635 A.

The de Glehn Four-Cylinder Compound. A. G. de Glehn. A discussion of the construction of this type of engine answering arguments that have been used to oppose it. 2600 w. Am Engr & R R Jour—Sept., 1902. No. 50407 C.

The Hayes Ten-Wheel Camel. C. H. Caruthers. Illustration with brief description of engines in service in 1853. 600 w. Loc Engng—Sept., 1902. No. 50416 C.

The Proper Handling of Compound Locomotives. Abstract of a paper by W. J. McCarroll read before the Trav. Engrs. Assn. Suggestions for handling compounds as they are at present constructed. 2500 w. R R Gaz—Sept. 26, 1902. No. 50807.

**Locomotive Trade.**

See Industrial Economics.

**Smoke Consumer.**

A New Locomotive Fuel Economizer and Smoke Consumer. Illustrated detailed description of the new smoke consumers being placed on the locomotives of the N. Y. C. & H. R. R. R. 1100 w. Eng News—Aug. 28, 1902. No. 50269.

**Tires.**

Methods of Fastening Tires to Car Wheels (Zur Radreifenbefestigung). Alois Schaffer. A study of the various methods of keying and securing tires to the wheels of railway vehicles, including the use of impact tools for upsetting the edge of the tire into the wheel rim. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 13, 1902. No. 50747 B.

Wear of Steel Tires in Germany. Reviews a recent summary of the report on the wear of steel tires on German railroads. 4400 w. R R Gaz—Sept. 12, 1902. No. 50519.

**Traction.**

Tractive-Power Formulae. George F. Summers. Gives approximate formulae arranged for the purpose of basing one engine upon experience with another. 700 w. Am Engr & R R Jour—Sept., 1902. No. 50411 C.

**Train Lighting.**

The Electric Lighting of Corridor Trains on the Prussian State Railways. (Die Elektrische Beleuchtung einiger D-Züge der Preussischen Staatsbahn-Verwaltung) H. Wichert. Describing the use of the de Laval steam turbine, driving a dynamo mounted on the locomotive, for producing current for electric lighting of railway trains. 5000 w. Glasers Annalen—Aug. 15, 1902. No. 50715 D.

The Lighting of Railway Trains in Continental Europe. Henri Guérin. A systematic account of train lighting systems on the Continent, including oil, gas, acetylene, and electricity. 3500 w. Engineering Magazine—October, 1902. No. 50786 B.

## NEW PROJECTS.

**Pennsylvania Railroad.**

The Pennsylvania Railroad in New York. An article by H. G. Prout, printed in the *N. Y. Times.* A sketch map of the new line across New York city, a discussion of the great undertaking and its object. 1500 w. R R Gaz—Sept. 19, 1902. No. 50594.

## PERMANENT WAY AND BUILDINGS.

**Detour.**

The Pennsylvania Railroad in New York Central & Hudson River Railroad. Alignment, profile and brief description of an important improvement saving a heavy grade and the passage of many trains through the city at the street level. 350 w. R R Gaz—Sept. 19, 1902. No. 50593.

**Locomotive House.**

The Locomotive House of the Austrian State Railways at Knittelfeld (Heizhaus Knittelfeld der K. K. Oesterreichischen Staatsbahnen). Oskar Rother. With description of round house, coaling plant, and general mechanical installation. 3500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 30, 1902. No. 50745 B.

**Mountain Railways.**

Remarkable Engineering Feats in Railroad Work. Charles F. Holder. Brief illustrated description of the road at Mt. Tamalpais, north of San Francisco, and the bridge across Cañon Diablo. 700 w. Sci Am—Aug. 30, 1902. No. 50242.

**Oil Storage.**

Oil-Storage Station. Illustrated description of the oil-storage station of the Hoosic tunnel on the Boston & Maine R. R. 1500 w. Am Engr & R R Jour—Sept., 1902. No. 50409 C.

**Shops.**

Michigan Central Shop Improvements at Jackson, Mich. An illustrated description of improvements being made which include a new central power and lighting station, and the building of a large addition to the machine and erecting shop. 2300 w. R R Gaz—Sept. 19, 1902. No. 50591.

Shop Improvements on the Southern California R. R. Illustrates and describes the enlargement and extension of these shops at San Bernardino, Cal. 1100 w. R R Gaz—Aug. 29, 1902. No. 50273.

**Signalling.**

Harrison Street Low-Pressure Pneumatic Interlocking. Brief illustrated description of a plant installed in Chicago. 600 w. R R Gaz—Sept. 19, 1902. No. 50592.

The Development of Railway Signalling. W. P. Digby. An illustrated article reviewing the various improvements in railway signalling. 2400 w. Transport—Sept. 5, 1902. No. 50550 A.

**Stations.**

Improvements at the St. Paul Union Depot. Abstract of a report submitted by Henry M. Sperry, describing these improvements which will greatly increase the facilities of this station. 2000 w. R R Gaz—Aug. 29, 1902. No. 50272.

**Terminals.**

The Proper Method of Counting Cars Handled Over Terminals in Figuring Cost of Handling Per Car. R. V. Miller. Gives a few of the methods of counting cars and the method recommended by the writer. 3000 w. St. Louis Ry Club—Aug. 6, 1902. No. 50283.

**Tracks.**

Some Advice on Track Work. Extracts from an address by W. L. Park to the roadmasters and section foremen on a division of the Union Pacific R. R. 1700 w. Ry & Engng Rev—Sept. 6, 1902. No. 50421.

**Tunnels.**

See Civil Engineering, Construction.

### MISCELLANY.

**Düsseldorf Exposition.**

Railway and Transportation Exhibits (Das Eisenbahn und Verkehrswesen). M. Buhle. The first of a series of illustrated articles describing in detail the exhibits of railway material and appliances at Düsseldorf in 1902. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Aug. 16, 1902. No. 50701 D.

**Europe.**

European Railway Notes. Angus Sinclair. Principally discussing customs in Great Britain. 1800 w. Loc Engng—Sept., 1902. No. 50419 C.

**Great Britain.**

Board of Trade Control Over Railroads in Great Britain. H. Raynor Wilson. An explanation of what this control consists and how the power is exercised. 5200 w. R R Gaz—Sept. 5, 1902. Serial. 1st part. No. 50389.

## STREET AND ELECTRIC RAILWAYS

**Acceleration.**

The Increased Acceleration on the Liverpool Overhead Railway. A description of the equipment being installed to obtain very high acceleration to meet competition. 2000 w. Tram & Ry Wld—Sept. 11, 1902. No. 50802 B.

**Accidents.**

Accidents on Electric Railroads. C. R. Barnes. Read before the convention of the N. Y. State Ry. Assn. Discusses various classes of accidents and their causes, and matters of related interest. 3200 w. St Ry Jour—Sept. 13, 1902. Serial. 1st part. No. 50536 D.

Accidents on Street Railways from the Legal Point of View. Joseph F. Daly. Read at Caldwell meeting of the N. Y. State St. Ry. Assn. Discusses the immense number of cases to be dealt with by the courts, and the steps necessary for relief of the courts, so as not to unduly delay other cases. 3800 w. St Ry Jour—Sept. 20. 1902. No. 50661 D.

President Roosevelt in a Trolley Accident. An illustrated article giving as accurate a statement of the facts as is now obtainable. 1200 w. St Ry Jour—Sept. 13, 1902. No. 50529 D.

The Handling of Accident Claims. William A. Dibbs. Read before the N. Y. St. Ry. Convention. Describes methods of dealing with such claims. 2400 w. St Ry Jour—Sept. 13, 1902. No. 50534 D.

**Birkdale.**

Electricity for Birkdale. Illustrates and describes a new generating station erected to supply electricity for tramways and lighting. 3200 w. Tram & Ry Wld—Sept. 11, 1902. No. 50803 B.

**Brakes.**

Brakes for Tram Cars. C. J. Spencer. Read before the Assn. of Munic. Tram. Mgrs. Discusses the question of brakes, reporting tests made of the slipper brake. 2500 w. Tram & Ry Wld—Aug. 7, 1902. No. 50264 B.

**Cars.**

Cars for the New York Subway. An illustrated description of two experimental cars built as samples for use in the subway. Also comparison with the Manhattan Elevated cars. 1200 w. St Ry Jour—Sept. 20. 1902. No. 50659 D.

**Conduit System.**

Conduit Electric Tramways. Illustrated description of the reconstruction of the Tooting lines of the London County Council Tramways. 4600 w. Tram & Ry Wld—Sept. 11, 1902. No. 50800 B.

New Conduit Work of the Brussels Tramway Company. Illustrated description of work being carried out. The conduit is laid under one of the rails, instead of between the rails, as in America. 2500 w. St Ry Jour—Sept. 6. 1902. No. 50380 D.

**Curves.**

A Graphical Method of Making Time-Speed Curves. Walter S. Valentine. Describes a method devised by the writer which greatly facilitates the construction of these curves. 1400 w. St Ry Jour—Sept. 6, 1902. No. 50377 D.

**Discipline.**

Discipline. C. B. Fairchild. Read at convention of the N. Y. State St. Ry. Assn. A discussion of matters relating to the proper discipline of employees. 5000 w. St Ry Jour—Sept. 13, 1902. No. 50535 D.

**Electric Locomotive.**

Electric Locomotive for Freight and Industrial Service. Remarks on the class of work for which these locomotives are adapted, with illustrated descriptions of recent installations. 1400 w. St Ry Jour —Sept. 13, 1902. No. 50531 D.

**England.**

The Electrification of Our Railways. A discussion of what has been done and ought to be done in London and suburbs especially, criticising the attitude of the railway companies. 3700 w. Elec Rev, Lond—Aug. 22, 1902. No. 50353 A.

**Expenses.**

Operating Expenses. J. B. Hamilton. Read before the Munic. Tram. Mgrs. Assn. Notes regarding practice on some American tramway systems. 2800 w. Tram & Ry Wld—Aug. 7, 1902. No. 50265 B.

**Halifax.**

The Tramway System of Halifax, England. An illustrated article giving particulars of the system and its power equipment. 3500 w. St Ry Jour—Sept. 6, 1902. No. 50375 D.

**High Speed.**

A Critical Review of the High-Speed Electric Trains at Zossen. Robert Grimshaw. 3000 w. Sci Am Sup—Sept. 6, 1902. No. 50406.

**Highways.**

Relation between Macadam Roads and Electric Street Railways. Edward P. North. Read at the Good Roads convention. Discusses the effect of electric railways in developing country districts and their influence on road maintenance. 1500 w. Eng Rec—Sept. 13, 1902. No. 50525.

Street Railways and State Highways. Harold Parker. Remarks referring especially to Massachusetts. 1800 w. Jour Assn of Engng Socs—Aug., 1902. No. 50692 C.

**Improvements.**

Recent Improvements on the Metropolitan Railway of Paris. Describes and illustrates the two-motor car train system recently installed on this underground electric road. 1400 w. St Ry Jour—Sept. 6, 1902. No. 50378 D.

**Interurban.**

An Important Interurban Road in Southern Ohio. Illustrated description of an interurban road 39.5 miles long, connecting Dayton and Greenville, Ohio, its equipment, operation, etc. 4500 w. St Ry Jour—Sept. 6, 1902. No. 50379 D.

Car Dispatching on Interurban Lines. Thomas E. Mitten. Read at convention of the N. Y. State St. Ry. Assn. An explanation of a system devised by the writer which, while similar to steam railway practice, is more flexible and simple. 3000 w. St Ry Jour—Sept. 20, 1902. No. 50662 D.

The Aurora, Elgin & Chicago Interurban Railway. An illustrated description of a recently opened road extending west from Chicago, which is a good example of recent construction. 2200 w. R R Gaz —Sept. 26, 1902. No. 50806.

Track and Overhead System for an Interurban Electric Railway. Gilbert Hodges. A discussion of road bed and track work and the construction of an overhead electric system. 3800 w. Jour Assn of Engng Socs—Aug., 1902. No. 50691 C.

**Legislation.**

A Session of Tramway Legislation. Herbert M. Adler. Discusses some of the more important schemes sanctioned by the British Parliament in 1892, and considers the measures passed in the last session of Parliament. 2000 w. Engng—Aug. 22, 1902. Serial. 1st part. No. 50374 A.

**Legal Decisions.**

The Law of Master and Servant in Relation to Tramway Companies. J. Neville Porter. A report of several interesting decisions in the British courts. 2500 w. Tram & Ry Wld—Sept. 11, 1902. Serial. 1st part. No. 50805 B.

**New York.**

Street Railway Situation in New York. G. Tracy Rogers. Presidential address at Caldwell meeting of the St. Ry. Assn. of the State of N. Y. 4000 w. St Ry Jour—Sept. 13, 1902. No. 50532 D.

**Power Station.**

New Power Station and Car House at Manchester, England. An illustrated article giving particulars of interest in regard to the new Stuart Street works, which combines under one roof two complete stations of considerably different design. 2500 w. St Ry Jour—Sept. 6, 1902. No. 50376 D.

New Power Stations of the Boston Elevated Railway. Illustrates and describes the Charlestown station, and the Lincoln Wharf station, giving information of interest. 4800 w. Engr, U S A—Sept. 1, 1902. No. 50280.

**Providence, R. I.**

The Street Railway System of Providence, Rhode Island, and Vicinity. George B. Francis. An illustrated article giving an account of this system. Also discussion. 3000 w. Jour Assn of Engng Socs—Aug., 1902. No. 50688 C.

**Rail Joints.**

Electric Welding of Rail Joints. An illustrated description of the machines used and methods of operation. 700 w. Ir Age—Sept. 25, 1902. No. 50668.

**Rapid Transit.**

The Rapid Transit Subway, New York. An illustrated article showing the method of carrying the electric tracks, with plan showing the progress of the entire work, and remarks on the engineering difficulties due to the conditions. 2100 w. Sci Am—Sept. 27, 1902. No. 50699.

**Rolling Stock.**

Tramway Rolling Stock. The first of a series of illustrated articles giving a general outline of various types of rolling stock. 2800 w. Tram & Ry Wld—Sept. 11, 1902. Serial. 1st part. No. 50804 B.

**Single Phase.**

Single-Phase Equipment for Washington, Baltimore & Annapolis Interurban Railway. Brief description of the equipment with single-phase alternating-current apparatus. 900 w. St Ry Jour—Sept. 13, 1902. No. 50530 D.

**Snow Handling.**

Removal of Snow and Ice in the Borough of Manhattan. W. Boardman Reed. Read at convention of the N. Y. State St. Ry. Assn. An account of the methods used in New York city to keep the tracks and streets clear of snow. 2000 w. St Ry Jour—Sept. 13, 1902. No. 50533 D.

**Station.**

Large Interurban Terminal Station in Cincinnati. Illustrated description of a building being erected by the Interurban Terminal Company. 800 w. St Ry Jour—Aug. 30, 1902. No. 50276.

The Aurora, Elgin & Chicago Railway Power Plant. An illustrated detailed description of a new generating station and its equipment. 3400 w. Steam Engng—Sept. 10, 1902. No. 50560.

**Tracks.**

Street Railway Track Construction in City Streets. Arthur L. Plimpton. Mainly an illustrated description of the track construction of the Boston Elevated Railway Company's system. Also discussion. 4800 w. Jour Assn of Engng Socs—Aug., 1902. No. 50689 C.

The Relation of Street Railway Tracks to the Paving of City Streets. Henry Manley. Considers points in which the tracks affect the maintenance of the street surface. 1200 w. Jour Assn of Engng Socs—Aug., 1902. No. 50690 C.

The Track Construction of Suburban and Interurban Electric Railways. S. S. Hoff. Read at meeting of the Penn. St. Ry. Assn. Discusses principally points relating to the construction through private property. 2700 w. St Ry Jour—Sept. 20, 1902. No. 50663 D.

The Track Construction of Suburban and Interurban Electric Railways. S. S. Hoff. Read before the Penn. St. Ry. Assn. Considers especially the construction through private property, discussing details. 2500 w. Elec Rev, N Y—Sept. 27, 1902. No. 50839.

Track Department of the Detroit United Railway. Illustrates and describes the interesting features of the work done by this department of a road now operating about 390 miles of track. Also describes the distribution system and overhead construction. 4000 w. St Ry Rev—Sept. 20, 1902. No. 50907 C.

Tracks in Tunnels. George Hebard Paine. Considers track construction with a view to determining the best for the traffic in the New York subways. Ill. 900 w. R R Gaz—Sept. 12, 1902. No. 50518.

**Traffic.**

Some Traffic Problems. C. R. Bellamy. Read before the Assn. of Munic. Tram. Mgrs. Discusses a few of the important problems in connection with the working of municipal tramways. 2200 w. Tram & Ry Wld—Aug. 7, 1902. No. 50263 B.

**Train Staff.**

The Train Staff for Electric Railroads. Editorial discussing the views of H. D. Emerson as given in the *Street Railway Journal*, advocating the use of the "train staff" in single-track interurban electric railroads. 1600 w. R R Gaz—Sept. 19, 1902. No. 50595.

**Transporters.**

Electric Truck for Carrying Standard Gauge Cars on Narrow Gauge Railways (Transporteur Electrique de Wagons à Voie Normal sur les Voies Etroites). A. Taveau. Illustrated description of an electrically propelled platform truck arranged to carry standard freight cars upon narrow gauge railways. 1800 w. 1 plate. Génie Civil—Aug. 23, 1902. No. 50721 D.

Wagon Transporters. From *Le Genie Civil*. Illustrated detailed description of transporters for carrying cars of large gauge over lines of smaller gauge, which have quite recently been experimented with at Rheims. 1200 w. Engr, Lond—Sept. 12, 1902. No. 50631 A.

**Underground.**

Underground Tube Railways. P. V. McMahon. Read before the International Tramways Congress. Compares the tube railway and the shallow tunnel tramway, discusses the general conditions, giving a brief description of the existing tubes in London and a few results of their working. 3600 w. Tram & Ry Wld—Aug. 7, 1902. No. 50262 B.

**Warrington.**

Electric Tramways at Warrington. Illustrated description of the tramway construction in this English town. Current for lighting and power will be furnished and a destructor plant is connected. 3600 w. Tram & Ry Wld—Sept. 11, 1902. No. 50801 B.

**Yarmouth.**

Yarmouth Tramways. An illustrated detailed account of the municipal tramways of Great Yarmouth, Eng. 4000 w. Elec Engr, Lond—Aug. 22, 1902. No. 50-349 A.

# EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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## THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

# CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

### Aerial Navigation.

Aerial Navigation. A Practical Handbook on the Construction of Dirigible Balloons, Aerostats, Aeroplanes and Aeromotors. By Frederick Walker, C. E. Size, 8 in. by 5 in.; pp. XVI, 151; figures, 105. Price, $3.00. New York: D. Van Nostrand Company. London: Crosby, Lockwood and Son.

This book reviews the present state of the art of aerial navigation. In the first chapter the laws of flight are discussed, with practical illustrations of the wings of birds, bats and insects. Other chapters treat of aerostatics, aerodynamics, methods of propulsion, motive power and engines, and the structure and materials of air-ships. An important part of the volume is devoted to the actual embodiments of the different principles discussed, and most of the leading aerostats, aeroplanes and air-ships are illustrated and described, some in considerable detail.

### Bridge Design.

A Text Book of Roofs and Bridges. Part III. Bridge Design. By Mansfield Merriman and Henry S. Jacoby. Size, 9 in. by 6 in.; pp. VIII, 374; figures, 149; plates, 7. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

In the present fourth edition, this standard text book has been entirely rewritten and brought fully up to date, in order to keep it abreast of modern bridge design, which has undergone remarkable changes in recent years. The new design of girders and simple trusses conform to the latest specifications and the best practice, and numerous new standard details are described. This volume is confined to simple bridges, or those resting on two supports, other forms being discussed in a subsequent part of the series. The theory of stresses in simple trusses is laid down in still another volume, but the present work gives a very practical and complete treatment of the detailed design of bridges. Among others the chapters on bridge contracts and office work and on bridge shops and shop practice give information of the greatest practical importance, but which is too often neglected in college courses. Altogether, this work is a most useful one, particularly for students and young engineers.

### Copper.

The Copper Handbook. A Manual of the Copper Industry of the United States and Foreign Countries. Vol. II. By Horace J. Stevens. Size, 8½ in. by 5¾ in.; pp., 416. Price, $1 (paper); $2 (buckram); $3 (full morocco). Houghton, Mich.: Horace J. Stevens.

This is the 1902 edition of a work devoted entirely to copper and first published in 1900. The present edition has been greatly enlarged and its scope extended, its ten chapters treating, respectively, of the history of copper; chemistry and mineralogy of copper; metallurgy of copper; a glossary of mining terms; copper deposits of the world; copper deposits of the United States; leading foreign mines; Lake Superior copper mines; other United States copper mines; and statistics of copper. All the principal copper mines of the world are described in more or less detail, the account of the Lake Superior district being particularly full. The statistics include those of production, consumption, export and import, finance, etc., and have been brought up to date. The book contains a vast amount of useful information, systematically arranged, and is extremely valuable for any one interested in copper.

### Kinematics.

Traité de Cinématique Théorique. By H. Sicard, with notes by A. Labrousse. Size, 10 in. by 6½ in.; pp. VIII, 185; figures, 100. Paper covers. Paris: Gauthier-Villars.

This book, written by two professors of mathematics, contains all the essentials of theoretical kinematics. It is fully illustrated by diagrams, and is written and arranged in the clear and elegant French mathematical style.

### Materials of Machines.

Materials of Machines. By Albert W. Smith. Size, 7½ in. by 5 in.; pp. 142; figures, 17. Price, $1.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

This book, as stated in the prefatory note, "is a result of an effort to bring together concisely the information necessary to him who has to select materials for machine parts," and the author, who is the professor of mechanical engineering in Leland Stanford Junior University, has succeeded remarkably well in attaining his object. There is a clear outline of the metallurgy of iron and steel and of testing, after which the various metals and alloys which enter into the construction of machines are discussed in detail, and the most suitable materials for different parts of machines are indicated. There are many large treatises on the resistance of material in general and others on machine design in general, but the present little volume combines in a happy degree the essentials of the larger works which concern its immediate subject.

**Mineral Industry.**

The Mineral Industry, Its Statistics, Technology and Trade in the United States and Other Countries to the End of 1901. Vol. X. Edited by Joseph Struthers, Ph. D. Size, 9½ in. by 6½ in.; pp. XXX., 920; figures, diagrams and tables. Price, $5.00 (£1, 10d.) New York and London: The Engineering and Mining Journal (Inc.)

The present volume supplements the preceding nine volumes of the series founded by the late Richard P. Rothwell, and, as such, needs no introduction to the mineral and metal world. This encyclopedic work has become such a well-recognized institution that it is its own best advocate, and praise seems superfluous. It may be said, however, that in this latest volume the high standard formerly established has been maintained, and the new editor is to be heartily congratulated on the result of his labors, which can be fully appreciated only bv those who have worked in neighboring fields. As is well known, the various mineral and metallurgical products of the world are taken up in alphabetical order, statistics given of their amount and cost of production, their prices, etc., new fields and processes are described and all other available information concerning them is brought up to date. There are also sections devoted to special subjects, such as pyritic smelting, metallography, mine timbering and support of earthworks, alloys as solutions, ore dressing, liquefied carbonic acid gas and the Wetherill system of magnetic concentration. Many of the foremost specialists in their respective lines have contributed signed articles to this book, which, together with its predecessors, forms an up-to-date encyclopedia of the broad subject covered by its title, and is absolutely indispensable to every one interested in the mineral and metal industries.

**Steel Specifications.**

Review and Text of the American Standard Specifications for Steel. By Albert Ladd Colby. Size, 7 in. by 5 in.; pp. 103; figures, 2. Price, $1.10. Easton, Pa.: The Chemical Publishing Co.

This book contains the revised text of the standard specifications for steel, adopted by the American Section of the International Association for Testing Materials, on August 10, 1901, this section, by the way, being now entirely separate from the international body. There are nine sets of specifications, those, namely, for castings, axles, forgings, tires, rails, splice bars, structural steel for buildings, structural steel for bridges and ships, and open-hearth boiler plate and rivet steel. The author reviews these specifications critically and gives the reasons which governed the drafting committee, of which he was a member, in its decisions. The specifications are practical and are the result of an effort to harmonize all interests. They are not intended to cover every specific purpose, but will serve for the majority of uses to which steel is applied, and can be modified to suit particular requirements without departing materially from the standard form and practice recommended.

**Steel Treatment.**

The Treatment of Steel. Size, 7 in. by 5 in.; pp. 162; figures, 6; plate, 1. Price, $1.00. Pittsburg, Pa.: Crucible Steel Company of America.

This is the third edition of a compilation from the publications of the Crescent Steel Company on heating, annealing, forging, hardening and tempering and on the use of furnaces. It also has a chapter on hardening and tempering from a work by George Ede, of Woolwich Arsenal, and one on "Why Does Steel Harden?" by W. Metcalf. This book is attractively gotten up and contains many useful and practical hints for steel makers.

## BOOKS ANNOUNCED.

The Engineer's Sketch-Book of Mechanical Movements, Devices, Appliances, Contrivances and Details Employed in the Design and Construction of Machinery for Every Purpose. 4th ed. By Fred. Walter Barber. Pp. 335. $4. New York: Spon & Chamberlain.

Self-Propelled Vehicles: A Practical Treatise on the Theory, Construction, Operation, Care and Management of all Forms of Automobiles. By James E. Homans. Pp. VI, 632; ill. $5. New York: Theodore Audel & Co.

Slide Valve Instruction Chart, Showing the Various Positions of the Crank Pin, Eccentric and Piston at the Point of Admission, Lead and Cut-Off. By Jos. Phinney Lisk. Size, 11 in. by 14½ in. 25 cents. New York: Spon & Chamberlain.

Tunneling: A Practical Treatise. 2nd edition. By Charles Prelini, with additions by Charles S. Hill. Pp. VI, 325; ill. $3. New York: D Van Nostrand Co.

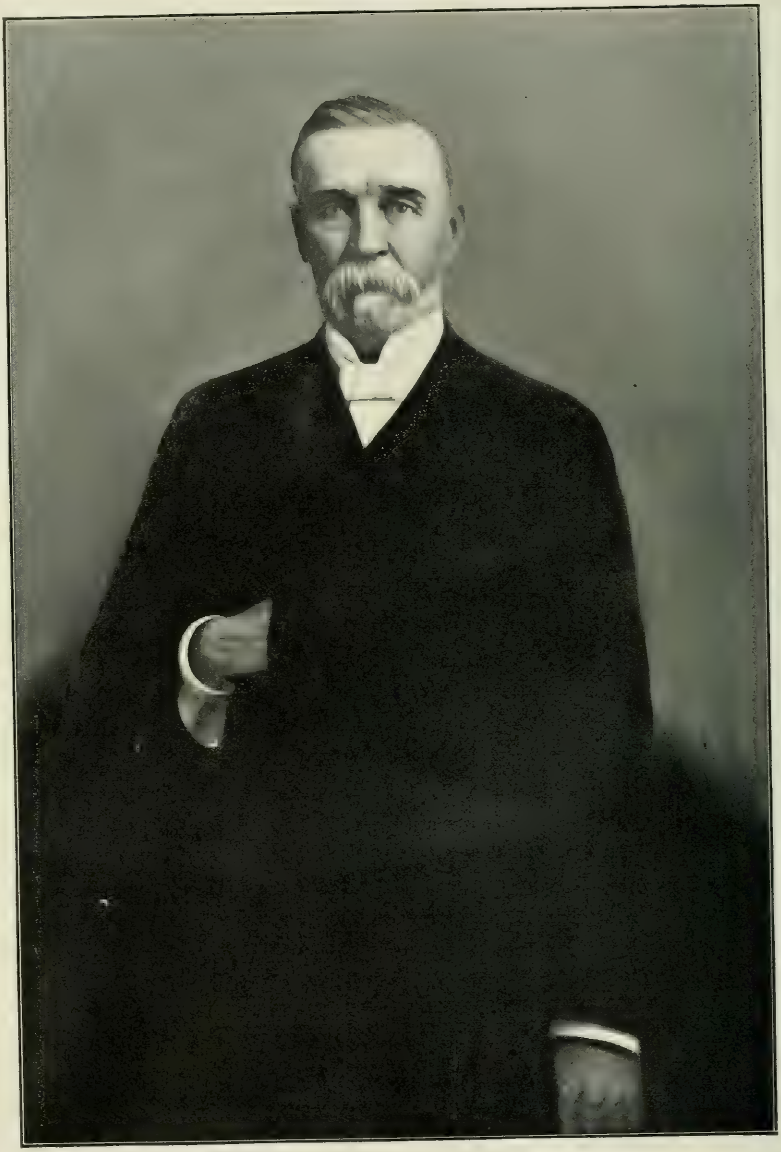
# THE

# ENGINEERING MAGAZINE

## AN INDUSTRIAL REVIEW

## December, 1902

NEW YORK
THE ENGINEERING MAGAZINE
1902



JOHN FRITZ.

From the original painting by Paul Hercher, in the possession of the American Society of Mechanical Engineers.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXIV. DECEMBER, 1902. NO. 3.

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# THE PANAMA CANAL, AND THE REGULATION OF THE CHAGRES RIVER.

*By Gen. Henry L. Abbot. With an Editorial Introduction.*

NOW that the best route for the Isthmian Canal has been chosen, the matter of prime importance is the detailed project for doing the work. And in the construction, as in the selection, no consideration should prevail except the clear purpose to have the best. The only safe course—the only permissible course—is to learn every obtainable fact, and to devote the ablest and most unfettered engineering talent to the work of planning and building as the facts require.

It is with great pleasure, therefore, that THE ENGINEERING MAGAZINE again welcomes to its pages so able and dignified an expositor as General Abbot, and serves as the medium for him to place before the engineering public an abstract of the wonderful fund of data in his possession. These concern the key to the success of the Panama Canal—the Chagres River. Misunderstanding and misstatement about the river have rioted more wildly than its worst floods. It is part of the result of General Abbot's discussion to show that the Chagres is in fact "far from a menace—a most useful friend," "supplying all the water that can ever be demanded by any probable traffic for centuries to come," and yet with judicious regulation giving no annoyance to shipping on any part of the route. To the student of the hydraulics of rivers the following article will be of the utmost possible interest in its presentation of methods and data—a revelation in the systematic and elaborate study of the regimen of a stream. To everyone interested in the Isthmian Canal it will be a valuable demonstration of the soundness of the studies which have led to the adoption of the Panama line, the certainty that no menace need be feared from the floods of the Chagres, the assurance of a certain water supply for the summit levels, and last, but by no means least, the proof that the one-lake project adopted tentatively by the Isthmian Canal Commission, while perhaps sufficient for the preliminary and comparative studies, is not at all sufficient as a working plan. A little more than half of General Abbot's article is given to the general discussion of the Chagres river and contains many facts not before in print about the topography of its basin, its regimen, its discharge, its floods, and their regulation. This alone will dispel many widespread errors of belief, and show that far from being a stream *sui generis,* practically beyond control by ordinary methods, it is really less formidable than a class of streams engineers are entirely accustomed to improve. It is, indeed, extraordinarily similar in its flood-behavior to the Roanoke River, above Neal, North Carolina. It has never approached such extremes of oscillation or rapidity of rise as are shown by the Warrior and Black Warrior Rivers of Alabama. The highest flood ever known did not reach 40 feet; the most rapid rise was 25 feet in 17 hours. Such oscillations would not attract more than passing notice in the river cities of the western United States. If General Abbot did no more than refute such wild exaggerations as the "52-feet rise in 2-hours" myth his paper would have served a valuable purpose.

But the second half is of even more importance. The entire feasibility of regulating the Chagres is well understood by most engineers—certainly settled beyond question with the Commission. But the best method of securing both regulation and conservation of the water supply to feed the canal during the dry season is in more danger of misapprehension. The Isthmian Canal Commission, being under great pressure for an early report, had no time to investigate details; their function was to determine route, not working plans. They adopted, merely as a peg upon which to hang a comparative cost estimate, the "single-lake plan"—that is, one by which the Chagres is to be confined in one great summit lake by a single dam at Bohio, 27 miles from the sea. The fear is now that a new commission, perhaps similarly urged to haste in putting the work in hand, may accept the conclusion of their predecessors on their high authority, without finding time for the study which the subject really demands.

General Abbot's figures and reasoning show clearly that this would be a grave mistake. The objections are, briefly:—That to store in the one lake sufficient reserves for operation and wastage would involve a dam and a summit level higher than desirable for convenient lockage; further, the increased head above the dam would occasion larger loss by infiltration through the underlying strata, partly defeating its own purpose; and again, even at the utmost height which could be contemplated, the single lake would still receive the Chagres with flood force near Gamboa, and objectionable currents and possible silting up, with attendant necessity for frequent dredging, would interfere with navigation.

The alternative is the two-lake project, determined by the exhaustive studies of the *Comité Technique*—an international and unbiased body of engineers of the highest eminence and quite unhampered in the matter of time or expense in their investigations. By building a second dam at Alhajuela, 29 miles above the first, they would make *two* storage reservoirs, and gain the following advantages: —The lower reservoir, constituting the summit level of the canal, might have much less elevation above sea, as it would be required to store only about two-fifths of the flood reserves. The lowering of the Bohio dam, thus permitted, would reduce the head to 70 feet, greatly diminishing both the height of lockage and the danger of loss by leakage through the bottom strata; and the stream entering this lower lake could be so controlled at the second dam, confining the upper lake, as never to cause the slightest inconvenience or delay to navigation.

These are the conclusions reached by the *Comité Technique*—a commission including some of the most distinguished hydraulic engineers of the world—after careful and deliberative examination of the results of twenty years' systematic study. General Abbot condenses into the following article and its tables and figures the most important of the data deciding this view.—THE EDITORS.

THE long series of measurements made during the construction of the Panama Canal, and especially during the operations of the New Company, have given a knowledge of the Chagres river probably more definite and exact than that respecting any river of its size in the United States. It therefore possesses an interest to students of the hydraulics of rivers quite independent of its relations to the Isthmian Canal. Having made a careful personal inspection of its course from near its mouth to a point several miles above the site of the dam projected near Alhajuela, and having made a professional study in detail of all the data collected by the two canal companies since the date of the commencement of operations in 1881, I have considered that a presentation of the facts bearing upon the physics and hydraulics of the stream, and upon its regulation for the purposes of a canal, might not be other than a useful contribution at the present time.

*Topography of the Basin above Bohio.*—The river heads in the Cordillera de San Blas, which here forms the continental divide and separates its waters from the Pacific. Two principal branches constitute the stream; one, known as the Pequeni, heads only about 5 miles from the Atlantic coast near Porto Bello; the other, which takes the name Chagres, although contributing less water than the Pequeni, heads in a direction a little south of east from this point and at an approximate distance of about 20 miles. The branches unite about 8 miles by the channel (3 as the crow flies) above Alhajuela, where is located one of the gauging stations of the New Company, just below the projected dam site.

This upper basin of the Chagres has been little explored, and the boundaries of its northern and eastern watersheds have never been traced. The region is covered with a dense forest of tropical vegetation, and the stream winds among low ridges believed not to exceed a thousand or fifteen hundred feet in height. For a few miles above Alhajuela the channel is bordered by limestone bluffs, passing below the stratified calcareous sandstone of the lower river, and often deeply undercut by the freshets of the torrential stream. The rock at a few localities is nearly white, and is sometimes worn into fantastic forms and draped by overhanging vegetation characteristic of the tropics. Rapids are here much more frequent than in the lower river. Taken as a whole, few regions offer greater natural beauties.

The middle sub-basin, lying between Alhajuela and Gamboa where the river joins the route of the canal, was traversed in a canoe in March, 1898, the water being about a foot above low-water stage. The total distance was about 11 miles, the width of the waterway being 100 to 300 feet, the channel depth about 3 feet, and the current ranging from 3 to 6 feet per second, giving a discharge of about 800 cubic feet. Eighteen rapids were counted, several of them requiring hard poling to surmount. The bed presented one marked peculiarity not seen in rivers having a regimen less torrential—the bars differed widely in composition. Some were of pure sand, others of pebbles, others of rounded stones 3 or more inches in diameter; there was little or no intermixing of materials. Evidently this peculiarity is due to the frequent freshets of the rainy season, which differ materially in volume and velocity and hence in transporting power. The water was beautifully clear; but the banks, although often of rock or protected by vegetable growth, were occasionally of clay showing evidence of moderate caving in times of high water.

In the lower sub-basin between Gamboa and Bohio the channel enlarges and the rapids in great part disappear. The caving banks increase in number, but as the entire region will be flooded by the projected lake, and thus be protected against erosion, this feature has no practical importance.

*Regimen of the Chagres.* The fact that the Chagres above Gamboa is essentially a clear-water stream was so well understood by the engineers of the New Company that no observations to determine the amount of earthy matter carried in suspension were deemed necessary. Fortunately, in view of the reckless misstatements that have been made respecting this element of the problem, the Isthmian Canal Commission investigated the volume of sedimentary matter quantitatively both for the Chagres and for the San Juan river at Sabalos Station near where it issues from Lake Nicaragua, and where naturally the water must be exceptionally pure. The results are presented for comparison in the first half of the following table, the second half being added to show the corresponding total discharges of the rivers as indicated by the gaugings of the Commission.

| Month 1900 | Solid matter in cubic yards at Alhajuela. | Bohio. | Sabalos Station. | Total discharge in acre-feet. Alhajuela. | Bohio. | Sabalos Station. |
|---|---|---|---|---|---|---|
| June ....... | 15,180 | 30,540 | 143,480 | 115,080 | 189,520 | 741,117 |
| July ....... | ..... | 152,760 | 207,762 | ...... | 366,470 | 1,073,149 |
| August .... | 81,230 | 116,000 | 166,247 | 251,730 | 361,550 | 1,288,735 |
| Sept. ...... | 41,660 | 79,360 | 122,595 | 184,520 | 308,830 | 1,266,473 |
| Oct. ....... | 97,000 | ...... | 113,203 | 300,610 | ...... | 1,752,367 |

Although these data are not reported in a unit permitting a comparison with similar observations on other streams, they make it evident that the volume of sedimentary matter which will be carried in suspension to Lake Bohio will have no practical importance. Whatever comes down will be deposited near the entrance where it can easily be removed by dredging. It is true that, in addition, some sand and gravel will be rolled along the bottom, but the volume will be unimportant, especially if the precaution be taken to regulate the freshets as well as the floods by an upper lake at Alhajuela.

The tributary streams below Alhajuela, although insignificant in the dry season, carry considerable volumes at times during the rainy months, and are not without importance in the problem of regulation. Seventeen of them enter between Alhajuela and Gamboa and fifteen thence to Bohio; and there are about thirty below. Several of them were gauged both by the Company and by the Commission, but as will appear below the results need not be considered here in detail.

Not only have the level surveys of the two companies given precise information as to the slopes and more important contours of the valley above Bohio, but fluviographs established at Gamboa in 1882, at Bohio before 1890, and at Alhajuela in 1899, have furnished a nearly continuous automatic record of river stages covering about twenty years. That at Gamboa where the Chagres first joins the canal was naturally regarded as the most important and is the most complete.

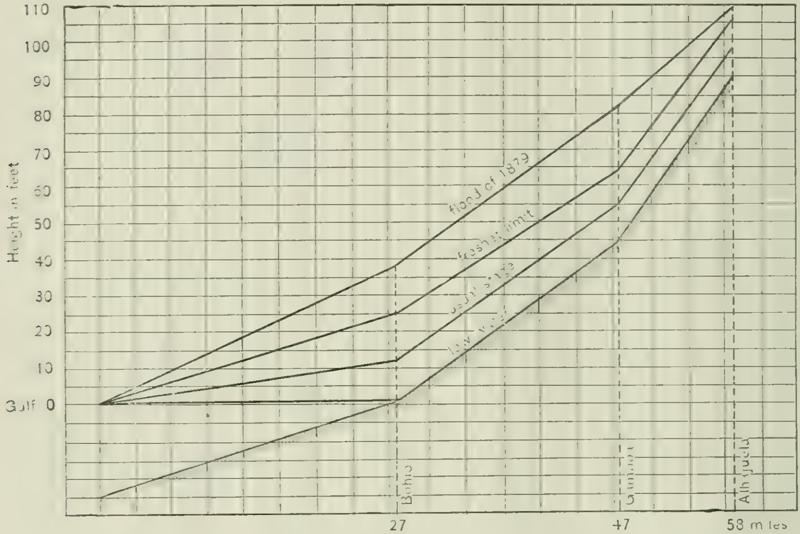

FIG. I. CHAGRES RIVER, VERTICAL SECTION.

The mean tidal oscillation at Colon, based on sixty months of daily observations between 1882 and 1887, is 1.43 feet, ranging from a maximum of 2.07 feet to a minimum of 0.62 feet. In extreme low water of the river the tidal level extends sensibly to Bohio, where a slight tidal oscillation of a few inches then appears. Ascending the river from this point the slope of the bed rises rapidly; and, as already stated, many rapids appear above Gamboa at low stages. They play an important part in the regimen of the stream, since they hold in reserve certain differences of level which when the river rises furnish an effective motive power to carry forward the increased volume, and thus reduce the oscillation between high- and low-water level. For example, the maximum variation noted during the past half-century at Bohio was 39.4 feet, becoming at Gamboa about 37.7 feet, while at

Alhajuela, although no authentic records are available, it could hardly have exceeded 18 feet. Relations like these can be better presented graphically than by tables, and attention is invited to Figure 1 for details.

As in all the rivers, there are considerable variations in the dimensions of the waterway at different localities near each other, but the following table giving those at the three gauging stations may be considered to represent the channel fairly under normal conditions in the neighboring parts of the valley. In it "height" refers to elevation above mean tidal level, and "velocity" to the maximum rate of flow as measured by surface floats following the thread of the current at the stages indicated.

| | Alhajuela, sea 58 miles. | | | | Gamboa, sea 47 miles. | | | | Bohio, sea 27 miles. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| River stage. | Height, ft. | Width, ft. | Area, sq. ft. | Veloc., ft. | Height, ft. | Width, ft. | Area, sq. ft. | Veloc., ft. | Height, ft. | Width, ft. | Area, sq. ft. | Veloc., ft. |
| Low water .. | 92 | 232 | 689 | 1.0 | 46 | 170 | 1,250 | 1.1 | 1 | 189 | 615 | 2.1 |
| Usual stage.. | 99 | 248 | 2,239 | 10.8 | 56 | 188 | 3,014 | 6.9 | 13 | 236 | 3.079 | 5.9 |
| High freshet. | 107 | 284 | 4,661 | 12.1 | 70 | over | bank | 14.1 | 26 | 288 | 6,362 | 7.9 |
| Flood limit.. | 110? | 381 | 5,834 | ? | 83 | over | bank | ? | 39 | over | bank | ? |

The lowest water level of record occurred in April, 1901, being at Alhajuela 28.0 metres (91.86 feet), at Gamboa 13.72 metres (45.0 feet), and at Bohio 0.14 metres (0.46 feet) above mean tide. For convenience, the low stage at these three posts has been assumed as 28 metres, 14 metres, and 0 metres respectively; the superior limit of usual stages being 30 metres, 17 metres, and 4 metres. It may be remarked here that, as all the records and computations have been made in metric units, some slight discrepancies may be noted in this paper, due to the transformation into English units involving the neglect of small fractions.

The river year on the Isthmus is sharply divided, this being due to the marked variation in rainfall, which, inconsiderable in January, February, March, and April, is heavy in the eight other months. The great floods have always occurred in November or December. It is by a study of the very complete registers of the fluviograph at Gamboa that the regimen of the Chagres is best understood. Nearly twenty years are available, and the chief difficulty is to arrange the important elements in the most compact form for examination. This is attempted in the first table in the Appendix,* which gives the number of times in each month that the river rose above 17 metres (the beginning of freshets, 10 feet above dead-low water); the total number of hours in each month that it remained above this level; the highest level attained in each month above dead-low water (14 metres); and finally the local rainfall in inches. For a few months, exact figures showing the greatest height attained above low water are not at hand, although the fact is of record that it did not reach the 17-metre stage; in such cases the word "less" will be found in the table.

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* See page 367, this issue.

This tabular exhibit warrants important conclusions, which will be confirmed by the tables of discharge. February and March are the extreme low-water months, the river then rarely rising more than 3 feet above the lowest stage. January and April are similar, although small freshets sometimes occur, especially in January. The other months show slight differences among themselves, but are all characterized by freshets, averaging about three per month, but sometimes exceeding ten. They are of very short duration, the river rarely remaining above the 17-metre stage for four days in an entire month, and rising and falling rapidly. Nevertheless these freshets deliver considerable volumes of water, moving with high velocity and sweeping down the channel like great waves. The fluviograph records have enabled the rate of movement of their crests to be accurately noted; they traverse the 11 miles from Alhajuela to Gamboa in about 4 hours, and the 20 miles thence to Bohio in about 6.5 hours—indicating a rate of movement of about 4.5 feet per second, which of course is much less than that of the water itself. As will appear further on, investigations have shown that the interval of time which elapses between the heavy downpour of rain that causes a freshet and the arrival of its crest at Bohio varies from 24 hours to 48 hours, according to the locus of the storm. These facts make it evident that, with the system of telegraphic communication which will be demanded to operate the canal, an agent at adjustable waste weirs on Lake Bohio would have ample warning and could easily and judiciously regulate the level of that lake.

It should be understood that these freshets, notwithstanding their short duration, are the controlling feature in the monthly discharge, the volume carried sometimes increasing ten and even twenty times as they pass. Bearing this in mind, the following annual summary, covering the eight rainy months in the table in the Appendix, establishes the fact that there are considerable and progressive variations from year to year in the discharge; that during the operations of the old company the volume was excessive, culminating in 1886 and 1887; and that since that maximum it has diminished, apparently reaching a minimum in 1898 and 1899. Data for accurate estimates of discharge do not exist prior to 1890, and therefore this evidence of annual variation covering several years is presented here, in the form of a summary of freshets at Gamboa. That the same condition affects lake Nicaragua has been conclusively shown by the Isthmian Canal Commission; and a study of the rain record at Colon, nearly complete since 1862, leads to the same conclusion.

| Year. | No. of freshets. | Above 17 metres, hours. | Local rainfall, inches. |
|---|---|---|---|
| 1883 | 21 | 201 | 70.5 |
| 1884 | 25 | 334 | 87.1 |
| 1885 | 37 | 437 | 95.7 |
| 1886 | 43 | 437 | 97.8 |
| 1887 | 39+ | 649+ | 126.9 |
| 1888 | 29 | 596 | 100.3 |
| 1890 | 34 | 308 | 95.2 |
| 1891 | 10 | 116 | 74.6 |
| 1892 | 24 | 269 | 95.3 |
| 1893 | 12 | 220 | 107.9 |
| 1894 | 25 | 263 | 87.6 |
| 1895 | 7 | 54 | .... |
| 1897 | 14+ | 151+ | 102.5 |
| 1898 | 8 | 51 | 78.3 |
| 1899 | 8 | 57 | 70.5 |
| 1900 | 12 | 84 | 74.2 |
| 1901 | 13 | 107 | 90.0 |
| Means | 21.2 | 255 | 90.9 |

*Discharge of the Chagres.*—A trustworthy and safe valuation of the discharge of the river is naturally a matter of first importance in studying the project for a canal, and measurements were by no means neglected by the engineers of the old company; but when the work came under the control of the liquidator, and later under the New Company, a more systematic plan was put into operation. Detailed instructions were issued in September, 1889, defining the method to be followed, and it has continued in force up to the present time.

The location is carefully covered by seven transverse lines of soundings in parallel planes about 10 metres apart, which are frequently repeated to detect possible changes in the bed. Surface floats offering little resistance to the air, like bottles ballasted with water, are used to determine the velocity. They are started from a boat far enough above the base, which is from 60 to 80 metres long according to locality, to attain it with the full velocity of the water. The times of transit are noted to quarter seconds by the observer with the watch, the instants of passing the ranges being called out by the other observer who precedes the floats. Six transits are usually noted, two at the middle of the stream and the others about half-way to the banks.

Full reports, including water level at the fluviograph and every detail, are submitted. The discharge is estimated by taking eight-tenths of the product of the mean velocity, as measured, by the area of cross section. Since 1889, with but few intermissions, the discharge has been thus measured at three-day intervals, and more frequently in times of freshets, at Gamboa and Bohio. Daily measurements were made at Alhajuela in 1895 and 1896, and since April, 1899, when they were resumed. During the last three or four years occasional night observations have been attempted to secure additional determinations of the velocity in large freshets.

In considering this method of gauging, the problem before the engineers of the Company should be borne in mind. The vital question was to determine whether the Chagres will supply all the needs of the canal in the season of low water. Any reasonable doubt here would be fatal to the project of a canal with locks, and no over-estimate of discharge could be tolerated. Hence the adoption of the coefficient eight-tenths, when nine-tenths would probably accord more nearly with the fact. The value was certainly safe and conservative, and in the plans for flood regulation due allowance for its probable insufficiency was made.

It remains to consider how, from these numerous gaugings, to determine the volume carried by the river in stated periods, the monthly and yearly discharges, for example. The most obvious manner is to adopt the mean of all the daily measurements as the true mean for the period in question. The objections to this plan for a river so variable as the Chagres are apparent. Ten days per month are too few for a correct average, especially as freshets by night escape measurement, thus unduly reducing the numerical mean. On the other hand, the comparatively few gaugings during a freshet, when the discharge is undergoing almost momentary variation, are likely to furnish too large a volume, from the natural tendency to multiply observations at the higher levels, thus unduly increasing the numerical mean. Furthermore, as direct gaugings were not made in the great flood of 1879, the greatest of record and therefore the true standard for estimating the provisions needful for regulation, it becomes necessary to infer logically the true discharge at stages considerably above any actually measured. It is evident from these considerations that the problem can be solved in a satisfactory manner only by applying to the hourly stages, known from the fluviograph sheets, a rating table derived from the very numerous gaugings made between lowest and highest river stages.

The construction of a trustworthy rating table for a torrential river like the Chagres is by no means a simple problem. In all rivers the discharge at a given stage is always greater when the water is rising than when falling, owing to the greater local slope affecting the flow. To represent the river truly, the rating table must take account of this law by indicating the mean between the rising and falling branches of the curve, and this the mean of so many measurements will correctly represent. Such tables are often constructed by drawing an arbitrary line to reproduce as accurately as possible the average of the platted observations; but when it is needful, as in the present case, to extend the curve beyond the limit of the observations, the general law of its curvature should be studied and represented by a formula, thus extending this law to the unknown portion and eliminating arbitrary assumptions. As this unknown portion was less than 10 per cent. of the whole curve at Gamboa, and less than 20 per cent. at Bohio, it is safe to assume that the predicted maximum discharge can involve no serious error. In framing the formula either the method of least squares or the graphical method may be employed, but as the relative weight to be accorded to the higher observations was not easily estimated, the latter was preferred. The following formulæ resulted from the study, based for Gamboa on over 1,500 gaugings, for Bohio on over 1,000 gaugings, and for Alhajuela on over 500 gaugings. In them $Q$ denotes the discharge in cubic metres per second, and $C$ the height of the water level above mean sea level, in metres.

Alhajuela, $Q = -8 + 52(C - 27.5)^2 - 1.6(C - 27.5)^3$
Gamboa, $Q = -26 + 24(C - 13) + 18(C - 13)^2 - 0.5(C - 13)^3$
Bohio, $Q = 47C + 5C^2 + C^3$

The accordance between these formulæ and the observations from which they were derived left nothing to be desired for the general case, but to estimate the hourly discharge during the rapid oscillations of the river some further refinement was found to be necessary both at Gamboa and at Bohio. At Alhajuela this was not required, because no measurements in the great floods of the river were there available, and the largest freshets were well represented by the formula.

For a great river like the Mississippi, where the general water level changes from month to month, and where consequently the rises start from very different levels at different seasons, the problem becomes complex; but for a river like the Chagres, which between freshets always subsides to a comparatively low and little varying level, advantage may be taken of the fact by grouping the freshets for separate study, and thus investigating the influence on the discharge exerted by the rapidly varying local slopes, then so different from the condition in the great floods when, the whole channel being surcharged, the slope from hour to hour usually remains comparatively constant. This study was carefully made, the ample data permitting the selection of gaugings taken only at periods of rapid changes of water level, when the object sought, the mean line between the rising and falling branches, could be accurately recognized. Very many such freshets were studied both at Gamboa and Bohio; and not only was it found that accordant values resulted at each separate locality, but that they could be well represented by simply increasing in a nearly equal proportion the coefficients of the first power of the water-level term in the respective general formulæ. These special freshet formulæ, thus deduced, are the following, the variables having the same signification in these expressions as in the formulae given on page 339 preceding.

Gamboa, $Q=-26+40(C-13)+18(C-13)^2-0.5(C-13)^3$

Bohio, $Q=62C+5C^2+C^3$

In fine, the method adopted to determine the continuous discharge of the Chagres since January, 1898, and for previous dates when the bi-hourly fluviograph readings are at hand, has been the following:—When the river is at a stand, or changes its level gradually, the above general formulæ are used, or rather the rating tables derived from them. When a freshet occurs and the stream begins to rise rapidly, the special formula table takes its place until the original level is approximately regained—reference being made to any actual gaugings available, in case of uncertainty as to which formula should be used, an uncertainty which in practice hardly occurs, so pronounced are the changes of level in the Chagres. If space permitted the reproduction of the very numerous tables of daily discharge at the three most important localities in the valley, each value based on wholly independent data, their uniform conformity to the known conditions would leave no doubt as to their accuracy. Indeed, on one occasion a small clerical error in the tabulated bi-hourly fluviograph readings at Gamboa was detected from the resulting discrepancies in discharge as compared with that at Alhajuela and Bohio. The daily average values at the three posts are thus shown by internal evidence to be relatively correct and any absolute uncertainty, due to the use of the coefficient eight-tenths in reducing the original gaugings, must affect them equally. As such error, if any exists, lies on the side of safety, the figures may certainly be accepted for purposes of canal regulation. Few hydraulic data are better established.

As will appear later, the continuous discharge for as long a period as possible is an important element in the problem. The mean monthly values are given, in the second table of the Appendix,* for the thirteen years which have elapsed since the work passed from the control of the old company. In compiling it, preference has always been given to determinations by fluviograph readings and the rating tables; but when, in the earlier years, some gaps exist in these records, they have been supplied by averaging the actual gaugings. It may be added that a comparison of the two methods covering many months has demonstrated that the causes of error in the latter largely balance each other in practice, and that important discrepancies are rare. To supply some gaps in the first four years at Bohio, and a few in the earlier months at Alhajuela, use has been made of the well determined ratios to transfer discharges measured at Gamboa—ratios which will be discussed below. Finally as no other method of interpolation is available, the only missing mean monthly discharges, those at Gamboa in January, 1890, and those at all three posts in May, 1902, are supplied by the mean of the other twelve years.

It is believed that this table presents a trustworthy estimate of the volumes delivered by the Chagres during this long period; but it should be remembered that evidence has been offered above tending to show that the river recently has been passing through a period of minimum flow, and that the annual volume would probably be increased if it had been possible to include all the years since work on the canal began.

*Great Floods of the Chagres.*—Only five great floods have occurred since the canal operations were inaugurated, and the records of the Panama railroad show that no damages to the road occurred prior to the first of these floods, in 1879. These records cover half a century. The exceptional character of these occurrences and the little probability of frequent interference with canal traffic are therefore demonstrated. When floods do occur, however, they are sufficiently formidable to demand well considered measures of regulation, and accordingly all the existing records have received elaborate study.

It is to Gamboa that attention is chiefly attracted, not only because the river first attains the canal at that point but also because more data have been collected there than at any other single point. The bi-hourly discharges there are shown in Figure 2. The different floods will be treated in turn, beginning with the last and following back in order of date.

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* See page 368, this issue.

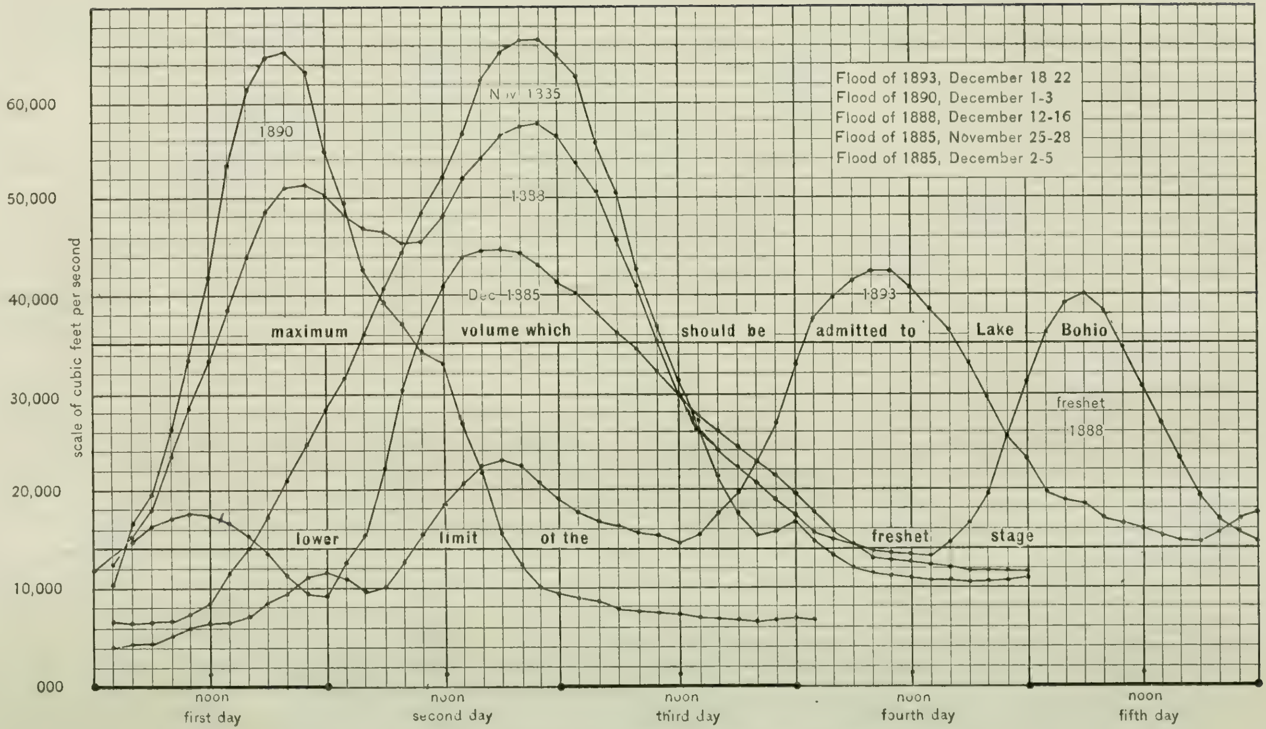


FIG. 2. BI-HOURLY DISCHARGES OF THE CHAGRES IN ITS GREAT FLOODS.

Flood of 1893.—This flood was carefully measured, and although it was the least formidable of any it merits special attention. After moderate showers on the 14, 15, and 16 of December, a heavy rainfall began on the evening of the 17 and continued until the 24. During these seven days 13.9 inches of rain fell at Gamboa, and 13.2 inches at Panama. The daily record at Colon was 1.02, 3.35, 4.64, 4.36, 3.47, 2.44, and 1.06 inches, making a total of 20.34 inches. The wind, shifting from south to west and northwest, blew in squalls and heavy gusts forcing the storm clouds over the entire Isthmus. The inundation caused but little damage. The current attained a velocity of from 8 to 10 feet per second, and brought down a few drift logs, and deposited some fine sand a short distance above Buena Vista.

The curve marked 1893 on Figure 2 exhibits the bi-hourly water levels and discharges by rating table at Gamboa during this flood. Fifteen actual measurements were made, and the following figures are added to illustrate how accurately the estimate by rating table and fluviograph represents the river. The discrepancy is only about 3 per cent., and that on the safe side.

| Date 1893 | Hour. | Height above sea, metres. | Discharge in feet seconds. | | | Remarks. |
|---|---|---|---|---|---|---|
| | | | Measured. | Tabular. | Difference. | |
| Dec. 19..... | 8:15 a. m. | 17.32 | 12,714 | 13.173 | —459 | |
| do. ..... | 9:00 a. m. | 17.52 | 13,420 | 14,223 | —813 | |
| do. ..... | 10:30 a. m. | 17.94 | 14,833 | 16,669 | —1,836 | |
| do. ..... | 4:40 p. m. | 18.94 | 23,380 | 22,850 | +530 | |
| Dec. 20..... | 8:45 a. m. | 17.79 | 15,857 | 15,751 | +106 | |
| Dec. 21..... | 9:50 a. m. | 21.52 | 35.757 | 35,939 | —182 | |
| do. ..... | 4:30 p. m. | 20.52 | 28,465 | 33,904 | —5,439 | River falling rapidly. |
| Dec. 22..... | 11:00 a. m. | 17.86 | 16,387 | 16,175 | +212 | |
| do. ..... | 3:20 p. m. | 17.63 | 14,409 | 14,868 | —459 | |
| Dec. 23..... | 7:35 a. m. | 17.05 | 11,619 | 11,760 | —141 | |
| do. ..... | 3.50 p. m. | 17.22 | 12,679 | 12,643 | +36 | |
| Dec. 24..... | 10:40 a. m. | 16.67 | 9,853 | 9,853 | 000 | |
| do. ..... | 3.10 p. m. | 16.31 | 7,805 | 8,193 | —388 | |
| Dec. 25..... | 8:10 a. m. | 15.89 | 7,452 | 6,392 | +1,060 | |
| do. ..... | 2:45 p. m. | 15.81 | 7,063 | 6,075 | +988 | |
| Means ... | | | 15,446 | 15,899 | —453 | |

It is shown by Figure 2 that the flood presented itself in three waves, of which the first and last were ordinary freshets, but that the intermediate rise attained at Gamboa at 9 a. m. on December 21 a level of 25.33 feet above low water, with a maximum volume of 43,086 cubic feet per second. The largest discharge in 48 hours occurred between 10 p. m. of December 20 and 10 p. m. of December 22, being 27,971 cubic feet per second, or 65 per cent. of the maximum. This percentage has an important bearing upon the problem of regulation, as will appear later.

The river in floods receives important contributions from the tributaries intermediate between Gamboa and Bohio, 20 miles below. Moreover the low lands of Tavernilla, between Bohio and San Pablo, are always inundated at such times, and this exerts an important regulating effect on the wave which reaches Bohio, reducing its height and prolonging its flow. These modifying influences in the flood of 1893 nearly masked the three waves and united them in one. The highest level attained at Bohio was reached at midnight on December 21, being 28.54 feet above low water with a maximum discharge of 51,100 cubic feet per second. The largest volume in 48 hours passed at the same time as at Gamboa, and was 43,590 cubic feet per second, or 85 per cent. of the maximum. To avoid confusion, the curves at Bohio are not shown on Figure 2.

Flood of 1890.—This flood was of a quite different type from that of 1893. The river at Gamboa rose with unexampled rapidity about 25 feet in 17 hours, and immediately subsided about 21 feet in 23 hours. These figures at Bohio were 19 feet in 31 hours and 11 feet in 14 hours. This is the most sudden and violent oscillation of the Chagres of which there are records, and it places in a strong light the exaggerations which have been current. The Senate Committee on Interoceanic Canals was informed under oath in February, 1902, that a rise "as high as 52 feet in 2 hours" was reported.

This flood was naturally more destructive than that of 1893. In the morning of December 1 the river began to rise rapidly, carrying huge drift logs and waifs of every description. At 9 p. m. it reached the flooring and swept away part of the bridge near Gorgona, wrecked a dredge, and did other damage. Railroad communication had already been interrupted between Matachin and Gorgona by 5 feet of water on the rails; it soon stood about 1.5 feet deep on the line between Bohio and Barbacoas and between Lion Hill and Gatun; and by 2 a. m. of December 2 it had invaded the line between Frijoles and Tavernilla. Traffic was restored on December 3 by the rapid fall of the river.

The highest level was reached at Gamboa at 8 p. m. on December 1, being 31.82 feet above low water; at Bohio it was reached at 1 p. m. of December 2 and remained unchanged for three hours, being 32.15 above low water. The corresponding discharges were 65,371 and 71,660 cubic feet per second. The largest average discharge in 48 hours at Gamboa occurred between 2 a. m. of December 1 and 2 a. m. of December 3, and was 34,752 cubic feet per second, or 54 per cent. of the maximum; at Bohio it occurred between noon of December 1 and noon of December 3, and was 51,068 cubic feet per second, or 71 per cent. of the maximum. Bi-hourly details are shown on Figure 2.

Only one actual gauging was made at Gamboa during this flood, at about 4 p. m. on December 2, indicating a discharge of 14,303 cubic feet per second, the river being 13 feet above low water. By fluviograph and rating table the volume was 19,636 cubic feet, the difference being explained by the fact that the river was falling rapidly. At Bohio two gaugings were made, at 7 a. m. and at 1 p. m., December 2, the river being 30.8 feet and 32.15 feet above low water. The corresponding discharges were 64,877 and 75,048 cubic feet per second The volumes by the fluviograph and rating table were 65,512 and 71,657 cubic feet.

Flood of 1888.—This flood, although it attained a less height by about 6 inches than that of 1890, was more formidable by reason of its long duration. The rise at Gamboa began on December 11 from a level only about 2 feet above low water, mounted rapidly about 22 feet, subsided slightly only to resume its upward movement, attained its highest point 31.37 feet above low water at 9 p. m. on December 13, subsided gradually for about 48 hours, and then after developing into a large freshet finally fell on December 17 below the 10-foot stage, which marks the lower limit of ordinary rises. It had remained above this stage for 128 hours. There were other freshets of moderate height but of unusual duration in this month, giving a record of 424 hours above the 10-foot stage, or more than double that of any other month in the 20 years of which we have records. December, 1888, would doubtless have tested any system of river regulation more severely than any other in the last half-century except November, 1879. Unfortunately no fluviograph record is available at Bohio. The extreme height there was about 34.68 feet above low water, indicating a discharge of 79,000 cubic feet per second.

At Gamboa the maximum discharge was 58,132 cubic feet per second; the largest in 48 hours, occurring between noon of the 12 and noon of the 14, was 48,278 cubic feet, or 83 per cent. of the maximum, the largest percentage noted. Bi-hourly details of the flood will be found on Figure 2, including those of the freshet which followed so closely on December 15-16 as to be not without importance in connection with the problem of regulation.

It may be remarked here that the distinction between the so-called freshets of the Chagres and its great floods is based not only on the extreme height attained but also on the duration. The floods result from heavy rainfalls in the basin, lasting for several days, while freshets follow much shorter downpours. In the latter, the high stage of the river seldom continues for more than 24 hours, and the average discharge in that period has been adopted as the standard for comparing them. This freshet of December 15-16 was one of the largest of them, giving the average discharge at Gamboa of 28,289 cubic feet per second for 24 hours. That of May 16-17, 1897, gave 30,549 cubic feet; that of November 27-28, 1901, gave 25,357 cubic feet. They are liable to occur in any month except February and March. Two of them occurred even in January, in 1902, giving discharges for 24 hours of 22,532 and 16,811 cubic feet per second. Such volumes, as will appear further on, are considered too large to be permitted to enter a route traversed by ocean steamers.

The inundation caused by the flood of 1888 was extensive. Communication by rail was interrupted for 24 hours or more between Matachin and Gorgona, between Frijoles and Tavernilla, between Bohio and Barbacoas, and between Lion Hill and Gatun. A dredge was swept away and one of the crew was drowned. Injuries were done to the canal between kilometre points 16 and 22, and other damages were reported.

Flood of 1885.—This flood also presented peculiar features. The rise at Gamboa began on November 25 from a level about 6.5 feet above low water, mounted steadily for 36 hours to the maximum height, 31.50 feet above low water, then "after a few moments" subsided rapidly nearly to the 10-foot level, there oscillated for 5 days, and finally on December 3-5 developed into a second flood smaller than the first but quite comparable at Gamboa with that of 1893. This was the first flood to occur after work had begun on the canal, and some attempts at measuring the discharge were made, but a diligent search among the old documents has failed to discover details as to methods of gauging or of reduction. An approximate rating table was made, which at some levels compares well with later studies. The fluviograph register has enabled the flood at Gamboa to be analyzed with precision, but unfortunately no records at Bohio are available.

The highest point was reached at Gamboa at 8 p. m. on November 26, with a discharge of 64,488 cubic feet per second. The greatest average for 48 hours, between 8 p. m. of November 25 and 8 p. m. of November 27, was 43,404 cubic feet, giving a ratio of 67 per cent. of the maximum. The second flood reached its highest level, 24.11 feet above low water, at from 4 to 6 p. m. on December 3, with a discharge of 44,923 cubic feet per second. The greatest average for 48 hours, between 5 a. m. of December 3 and 5 a. m. of December 5, was 32,421 cubic feet per second, giving a ratio of 72 per cent. The greatest heights attained at Bohio in these two rises were approximately 33.79 feet and 26.41 feet above low water, indicating discharges of 74,800 and 47,466 cubic feet per second.

Flood of 1879.—Abundant evidence exists to establish that this flood considerably exceeded any one of later date, and hence that any safe plan of regulation must take it into account. It occurred in November, when a violent rain storm with strong northerly winds prevailed for six days over the entire Isthmus. The only rain record was kept at Panama, where 12.6 inches fell; but this fact warrants no conclusion as to what fell in the valley of the Chagres, where precipitation is always much larger and is often double the amount at Panama. The river data are also meagre. An investigation of water levels was confided, shortly after the occurrence of the flood of 1888, to M. Sosa, a Colombian engineer of high repute who had been educated in the United States, and who subsequently became a member of the *Comité Technique*. He assured me personally that the evidence collected left no doubt that the volume carried in 1879 must have been much larger than in any later flood. The following figures exhibit his determinations of relative level in what are unquestionably the two greatest known floods of the river. They give the height in feet above mean tide of the highest water levels.

| | Flood of 1879. | Flood of 1888. | Difference. |
|---|---|---|---|
| At Buena Vista | 43.96 | 39.96 | 4.00 |
| At Bohio | 39.37 | 34.68 | 4.69 |
| Difference | 4.59 | 5.28 | 0.69 |

Another examination made shortly after the flood of 1888 near San Pablo, where the railroad bridge at Barbacoas afforded a trustworthy point of reference, went to prove that there too the flood of 1879 reached a point "higher than in 1888 but not very much higher."

It has been suggested, in the desire to reduce the cost of the regulating works, that the extensive excavations made by the old canal company between 1879 and 1888 may have lowered the water level in the latter flood, and thus have suggested an exaggerated idea as to the relative volume carried in the former. The facts do not warrant this claim. The excavations near and above Bohio did not sensibly increase the direct channel way in that region, being oblique to and at a considerable distance from the direct route of flow. Near the site of the dam the natural channel of the river is contracted and sweeps round a sharp bend of more than 90 degrees, creating an obstruction that in floods must oppose much resistance and be the dominating obstacle to the flow. This obstacle was the same in both floods. Below Bohio considerable excavations had been made, and if they had tended to lower the water level their effect should have been much more apparent at Bohio, below the gorge, than at Buena Vista a mile and a half above. But the records just quoted indicate that the fall in water surface between Buena Vista and Bohio in the two floods was so nearly identical as to render the large difference in absolute level between them inexplicable upon any other supposition than that of a much larger volume passing in 1879 than in 1888. Moreover, as a matter of fact, in both floods the whole region below Bohio was deeply inundated, and in so enormous a waterway an increase of 2,500 square feet, largely estimated, could not have materially lowered the general level. On the contrary, the cuttings across the natural bends in the lower river may have caused in 1888 whirls and cross currents tending even to raise it. It is clear that the only conservative estimate to be formed of the maximum momentary discharge at Bohio in the flood of 1879, is that to be derived from the recorded water level 39.37 feet above zero; and this by the rating table is shown to be 112,730 cubic feet per second.

Unfortunately no water levels in this flood were secured at Gamboa, but the fact that the oscillations in this lower part of the basin are quite similar justifies the following computation, based on the comparative levels attained in the other four floods. The table gives the extreme heights above mean sea level in metres, and the figures below indicate the calculations to deduce the probable height at Gamboa. The probable levels at Bohio in the flood of 1885 are deduced in a similar manner.

| Locality | 1879 | Nov., 1885 | Dec., 1885 | 1888 | 1890 | 1893 |
|---|---|---|---|---|---|---|
| Gamboa ........ | 25.17? | 23.60 | 21.35 | 23.56 | 23.70 | 21.72 |
| Buena Vista.... | 13.40 | .... | .... | 12.18 | .... | .... |
| Bohio .......... | 12.00 | 10.30? | 8.05? | 10.57 | 9.80 | 8.70 |

$$23.56 + (12.00 - 10.57) = 24.99$$
$$23.56 + (13.40 - 12.18) = 24.78$$
$$23.70 + (12.00 - 9.80) = 25.90$$
$$21.72 + (12.00 - 8.70) = 25.02$$

Resulting height........ $25.17 \pm 0.17$ metres.

In other words, the extreme height of the flood of 1879 at Gamboa was 36.65 feet above low water, with a probable error of about 6 inches. This would indicate a maximum momentary discharge of 78,614 cubic feet per second.

*Regulation of the Floods.*—No one will claim that such floods as those just described can be allowed to enter a ship canal. Since the idea of a sea-level construction has been dropped by common consent, it would be useless to discuss the practicability of diverting such volumes into separate channels. The problem then resolves itself into determining what part of them should be held back temporarily, and where the reservoir lake or lakes should be located, when resort is had to the familiar method of slack-water navigation. The following summary of results already reached will be found convenient for reference. It will be remembered that low water at Bohio is taken as 0 metres, and at Gamboa as 14.0 metres above mean sea level.

| Flood. | At Gamboa. | | | | At Bohio. | | | |
|---|---|---|---|---|---|---|---|---|
| | Max. height ft. above l. w. | Discharge in ft. sec. Maximum. | In 48 hrs. | Per cent. | Max. height ft. above l. w. | Discharge in ft. sec. Maximum. | In 48 hrs. | Per cent. |
| 1893 .... | 25.33 | 43,086 | 27,971 | 65 | 28.54 | 51,100 | 43,590 | 85 |
| 1890 .... | 31.82 | 65,371 | 34,752 | 54 | 32.15 | 71,660 | 51,068 | 71 |
| 1888 .... | 31.37 | 58,132 | 48,278 | 83 | 34.68 | 79,000 | ? | ? |
| Nov., 1885 | 31.50 | 64,488 | 43,404 | 67 | 33.79 | 74,800 | ? | ? |
| Dec., 1885 | 24.11 | 44,923 | 32,421 | 72 | 26.41 | 47,466 | ? | ? |
| 1879 .... | 36.65 | 78,614 | ? | ? | 39.37 | 112,730 | ? | ? |

The facts known relative to the great floods warrant the belief that at Gamboa the period of danger may safely be estimated at 48 hours, and that the percentage of the maximum volume which passed in that period in 1879 may safely be taken at that measured in the similar flood of 1888, which was 83 per cent. These figures give for the total volume to be dealt with at Gamboa, in the greatest of known floods, a discharge of 65,250 cubic feet per second for 48 hours, or a total volume of 206,000 acre feet.

At Bohio the problem is more complex, by reason of considerable contributions from the intermediate tributaries, and of the reserved volumes held back by the flooded areas, which have always tended to reduce the maximum discharge and to prolong the duration of dangerous flow. Moreover fewer measured percentages are available there than at Gamboa, and those that are known rule higher, as is natural. Furthermore, the lowest practicable location for a dam is found at Bohio, and this introduces the question of what volume may safely be allowed to pass to the region below in these great floods. For these reasons a different mode of estimating the duration of danger at this point seems to be desirable.

Observations of present conditions and of the capacity of the channels to be provided below Bohio, satisfied the *Comité Technique* that about 42,000 cubic feet per second could be allowed to leave the artificial lake and pass thence independently to the sea, without causing serious overflow or otherwise interfering with the service of the canal. What especially calls for study, therefore, is the duration of the period in which the river at Bohio delivered a volume greater than this in each of the unknown floods, by noting what occurred in the two for which data have been preserved. This estimate may be made upon various suppositions, but the most logical and conservative appears to be that the duration in question was proportional to the relative maximum heights reached in the floods to be compared. This simply assumes that the hourly curve of rise and fall near the dangerous period in the unknown flood was essentially parallel to that observed in the known flood.

Applying this method to the floods of 1893 and 1890, it will be found from the tables of hourly flow that in the former the discharge equalled or exceeded 42,000 cubic feet per second between the hours of 10 a. m. on December 21 and 1 p. m. on December 22, a period of 27 hours; and in the latter between the hours of 7 p. m. on December 1 and 3 a. m. on December 3, a period of 32 hours,—the intermediate average discharges being 47,400 and 60,300 cubic feet per second. The extreme heights attained above low water and the corresponding maximum discharges are given in the last table. It remains to make use of these data for estimating the volumes which passed below Bohio in the four unknown floods by comparing each of them in turn with the two known floods as a standard.

STANDARD, THE FLOOD OF 1893 (47,400 FT. SEC. FOR 27 HOURS).

Flood of 1888... $\frac{47{,}400}{51{,}100} \times 79{,}000 = 73{,}320$ ft. sec. for $\frac{34.7}{28.5} \times 27 = 32.9$ hours

Flood Nov., 1885 $\frac{47{,}400}{51{,}100} \times 74{,}800 = 69{,}420$ ft. sec. for $\frac{33.8}{28.5} \times 27 = 32.0$ hours

Flood Dec., 1885 $\frac{47{,}400}{51{,}100} \times 47{,}466 = 44{,}100$ ft. sec. for $\frac{26.4}{28.5} \times 27 = 25.0$ hours

Flood of 1879... $\frac{47{,}400}{51{,}100} \times 112{,}730 = 104{,}600$ ft. sec. for $\frac{39.4}{28.5} \times 27 = 37.3$ hours

STANDARD, THE FLOOD OF 1890 (60,300 FT. SEC. FOR 32 HOURS).

Flood of 1888... $\frac{60{,}300}{71{,}660} \times 79{,}000 = 66{,}460$ ft. sec. for $\frac{34.7}{32.1} \times 32 = 34.6$ hours

Flood Nov., 1885 $\frac{60{,}300}{71{,}660} \times 74{,}800 = 62{,}900$ ft. sec. for $\frac{33.8}{32.1} \times 32 = 33.7$ hours

Flood Dec., 1885 $\frac{60{,}300}{71{,}660} \times 47{,}466 = 39{,}940$ ft. sec. for $\frac{26.4}{32.1} \times 32 = 26.3$ hours

Flood of 1879... $\frac{60{,}300}{71{,}660} \times 112{,}730 = 94{,}800$ ft. sec. for $\frac{39.4}{32.1} \times 32 = 39.3$ hours

In order to compare these results it is only needful to reduce them to a common unit, for example, the number of acre feet of water which should be impounded in the reservoir or reservoirs above Bohio in order to protect the canal and region below against inundation. This is done by deducting 42,000 from each of the above discharges, multiplying the remainders by the corresponding hours reduced to seconds, and dividing the product by 43,560 (the number of square feet in an acre). Performing these operations the following values for the needful capacity will be found:

| | |
|---|---|
| Flood of 1893 (actually measured) | 12,100 acre-feet |
| Flood of 1890 (actually measured) | 48,400 acre-feet |
| Flood of 1888 (compared with 1893) | 85,100 acre-feet |
| Flood of 1888 (compared with 1890) | 69,900 acre-feet |
| Flood Nov., 1885 (compared with 1893) | 72,600 acre-feet |
| Flood Nov., 1885 (compared with 1890) | 58,200 acre-feet |
| Flood Dec., 1885 (compared with 1893) | 4,330 acre-feet |
| Flood Dec., 1885 (compared with 1890) | Nothing |
| Flood of 1879 (compared with 1893) | 193,200 acre-feet |
| Flood of 1879 (compared with 1890) | 171,400 acre-feet |

These figures confirm what all the known facts and records tend to establish; to wit, that the flood of 1879 so much exceeded any other that it is a safe, and the only safe, standard upon which to base plans for regulation. In adopting definite figures, the indications based on the flood of 1893 should have preference, for although that of 1890 much exceeded it in violence, the exceptional suddenness of its rise and fall and its comparative short duration would make it an unsafe dependence. The flood of December 1885 has never heretofore been submitted to analysis, and the above figures demonstrate that at Bohio it had no importance; the volume, as will appear further on, proceeded chiefly from the upper Chagres, receiving but small contributions from the tributaries below Gamboa, but at that point it was sufficiently formidable to be worthy of consideration.

The precise reservoir capacity to be provided above Bohio is too important an element to be lightly treated, or to admit of an underestimate without incurring risks of serious calamities. It was the unanimous opinion of the *Comité Technique* that the flood of 1879, supplemented as to duration by the data secured in 1893, should form the basis of the projet. Furthermore, bearing in mind that the use of the ratio eight-tenths in reducing the gaugings (adopted to avoid any possible over-estimate of low-water supply) entails a safety coefficient for flood volumes, it was agreed unanimously to adopt 250,000,000 cubic metres (about 203,000 acre feet) as the total reservoir capacity demanded above Bohio. Such a reserve will protect the entire valley occupied jointly by the river and canal against overflow, provided a safe system of regulating the volume allowed to escape from lake Bohio is furnished. The latter can easily be effected by adopting the Stoney overflow weir (or some similar device) which has given perfect satisfaction on the Manchester Ship Canal, and which being operated at the lake itself will be controlled from what can be seen on the spot. Excellent outlets are available, well separated from the dams and locks and leaving nothing to be desired. The problem in Nicaragua would have been far more complex, as the overflow would have been at the dam itself, and the proper rate would have been wholly dependent on the conditions existing at the lake situated fifty miles away.

It remains to consider whether a single lake or two of them would furnish the best solution of the Panama problem. A dam at Bohio creating a lake extending at least to the point where the canal leaves the river near Gamboa is manifestly demanded. Should this lake receive dimensions sufficient to retain the entire volume, including that required for evaporation, infiltration, the generation of power, and the supply for canal lockages in the dry season? The objections to such a plan were found to be numerous and weighty.

The canal from the Atlantic coast to Bohio is projected at sea-level. A good location for two locks in flight is found near the best location for the dam at Bohio. It was considered desirable to limit the lifts to about 9 metres each, or say 30 feet. This would indicate, as the highest flood level of the lake, a height above mean tide of about 20 metres (66 feet). Elaborate surveys of the region above, to be flooded, showed that its surface would then cover about 5,500 hectares (13,592 acres) affording a capacity to store only about 150,000,000 cubic metres (121,600 acre feet). If then this lake were to be the only one in which to store the entire reserves, as well for canal operation and wastage as for flood regulation, its surface must be very considerably raised above the desired level, entailing locks with excessive lifts, as the site is not well adapted for three in flight. But this would not be the most objectionable feature in so considerably raising the desired lake level. At the site of the dam the river traverses a rocky gorge where a tertiary deposit of gravel and sand underlies at a considerable depth the present bed, but is itself overlaid by a thick stratum of sandy and compact clay furnishing a foundation well suited to an earthen dam to be subjected to a head not exceeding about 70 feet. To increase the pressure considerably might possibly cause infiltration through the underlying materials that would permit the escape of an undue portion of the canal reserves, and thus lead to waste and depletion of the volumes stored to meet the needs of the low-water season.

But these manifest difficulties at and below Bohio were by no means the only reasons for adopting a plan with two reservoir lakes. A single lake would allow the Chagres to strike the canal with its full force near Gamboa, not only in the occasional great floods but also in the freshets frequently occurring throughout eight months of the year. They often attain a momentary discharge of 25,000 to 35,000 cubic feet per second and bring down a moderate amount of sand and gravel, the latter of which has occasionally supplied ballast for the railroad. The entrance to the lake for 4 or 5 miles above Tavernilla is contracted and objectionable currents with frequent dredging at this locality would interfere more or less with the use of the canal by shipping. In a word, the Chagres should be regulated at its entrance into the transit route as well as in its lower course.

Nature has favored the plan with two lakes. An excellent dam site exists at Alhajuela, about 9 or 10 miles above in direct line, where the surveys have demonstrated that ample reserves may be stored for all the needs of the canal in the dry season, and for a flood reserve of 150,000,000 cubic metres (121,600 acre feet) to be held back and delivered gradually, as desired, after the flood has ceased. With such an upper lake there will be, of course, no difficulty in regulating the volume to be admitted to lake Bohio in ordinary freshets, even to the extent of giving a practically uniform flow to the stream. For these several reasons the *Comité Technique* was unanimously of opinion that the double-lake plan should have the preference.

It remains to consider how the 250,000,000 cubic metres constituting the total flood reserve should be divided between the two lakes. Occurring so rarely as do the great floods, it would appear that a volume of 1,000 cubic metres per second (35,000 cubic feet) may be permitted at such times to enter lake Bohio, giving in the contracted portion near Gamboa a velocity of about 1.6 miles per hour. Adopting this figure, the reserve to be held back at Alhajuela may be computed upon the same principles that have been applied above at Bohio. The conclusions will be even more definite, since all the floods except that of 1879 were actually measured at Gamboa. The following is the computation to make known the reservoir capacity that would have been required at Alhajuela to restrict the maximum volume allowed to enter lake Bohio in each of the great floods to the quantity of 35,000 cubic feet per second.

STANDARD, THE FLOOD OF 1893 (39,378 FT. SEC. FOR 16 HOURS).

Flood of 1879.... $\frac{39,378}{43,086} \times 78,614 = 71,850$ ft. sec. for $\frac{36.65}{25.33} \times 16 = 23.16$ hours

STANDARD, THE FLOOD OF 1890 (50,291 FT. SEC. FOR 23 HOURS).

Flood of 1879.... $\frac{50,291}{65,371} \times 78,614 = 60,480$ ft. sec. for $\frac{36.65}{31.82} \times 23 = 26.50$ hours

STANDARD, THE FLOOD OF 1888 (48,947 FT. SEC. FOR 45 HOURS).

Flood of 1879.... $\frac{48,947}{58,132} \times 78,614 = 66,190$ ft. sec. for $\frac{36.65}{31.37} \times 45 = 52.57$ hours

STANDARD, THE FLOOD OF NOV., 1885 (51,456 FT. SEC. FOR 31 HOURS).

Flood of 1879.... $\frac{51,456}{64,488} \times 78,614 = 62,730$ ft. sec. for $\frac{36.65}{31.50} \times 31 = 36.03$ hours

STANDARD, THE FLOOD OF DEC., 1885 (40,826 FT. SEC. FOR 24 HOURS).

Flood of 1879.... $\frac{40,826}{44,923} \times 78,614 = 71,460$ ft. sec. for $\frac{36.65}{24.11} \times 24 = 36.48$ hours

Reducing, as before, to a common unit for comparison:

| | |
|---|---|
| Flood of 1893 (actually measured)............ | 5,790 acre feet |
| Flood of 1890 (actually measured)............ | 29,050 acre feet |
| Flood of 1888 (actually measured)............ | 51,880 acre feet |
| Flood of Nov., 1885 (actually measured)....... | 42,140 acre feet |
| Flood of Dec., 1885 (actually measured)....... | 11,560 acre feet |
| Flood of 1879 (compared with 1893).......... | 70,500 acre feet |
| ditto (compared with 1890).......... | 55,800 acre feet |
| " (compared with 1888).......... | 135,500 acre feet |
| " (compared with Nov., 1885)..... | 82,700 acre feet |
| " (compared with Dec., 1885)..... | 109,600 acre feet |

These figures would seem to leave no doubt, if for no other reason than to guard against annoying currents, gravel and sand deposits, and delays in canal operation at the contracted entrance to Lake Bohio, that the lake at Alhajuela should be regarded as an essential element of the regulation of the Chagres. It should provide for the temporary storage of about 150,000,000 cubic metres (121,600 acre feet), leaving the remaining 100,000,000 cubic metres (81,100 acre feet) to be held back in Lake Bohio. This was the plan proposed by the engineers of the New Company in the low-level projet.

These flood reserves have been questioned, in *Le Génie Civil,* as perhaps needlessly large, because based on the estimated requirements of the flood of 1879 concerning which existing data are defective; and the idea has been advanced that the flood of 1888 might better have been adopted as the standard. The chief point of uncertainty at Bohio is the probable duration of excessive discharge, which neither in the flood of 1879 nor in that of 1888 is of record. It will be noted from the above figures that at Gamboa, where several floods are well understood, the conclusions as to their relative importance reached by the study at Bohio are amply confirmed. In an element of so great importance as flood regulation in a route to be traversed by the commerce of the world, any error should lie on the side of safety. Furthermore, the unexampled duration of high water at Gamboa in the month of December, 1888, (424 hours above the lower limit of freshets) suggests that if more complete data even for that month were available the requirements estimated above based on what occurred in the 45 hours of greatest flow might be increased. What is certain is that in both the floods of 1879 and 1888 the river exhibited powers of offense not judiciously to be underrated.

In fine, by the projet adopted by the New Panama Canal Company the entire river is regulated. Neither in the great floods nor in the frequent freshets will the passage of the largest ships be retarded at the entrance of the lake near Gamboa; locks of moderate lift will afford ready access to it at Bohio; and the volume allowed to escape to the region below will not exceed what can readily pass through separate channels to the sea without in any degree encroaching upon the canal. Incidentally, the difficulties in the construction of a dam at Bohio will be very greatly reduced, as compared with any single-lake projet, and, as will appear below, the low-water reserve will be secured against any possible danger of reduction by undue infiltration. Such are the merits of the double-lake plan of regulation.

*Ratio between Downfall and Drainage.*—Before considering the matter of water supply for the canal during the season of low water, it seems desirable to refer to a criticism which has been raised against dependence upon artificial lakes in which to store such reserves.

In the Additional Report of the Senate Committee on Interoceanic Canals dated January 7, 1901, appears the following statement:

> "We cannot know in advance what an artificial lake can supply to meet the emergencies of the dry season in a torrid country where the bottom of the basin is left in its natural condition and may be inadequate to retain the waters impounded in it, and this problem cannot be determined except by long experience. In this case no effort has been made to solve this vital question; it is left entirely to conjecture. As this is a factor in the problem on which the entire question of a water supply depends, the absence of any practical effort to solve it is conclusive against its adoption."

The writer of this paragraph was ill informed. The problem had been carefully considered by the engineers of the New Company, and a preliminary study of the results of the investigation had appeared in a Government publication which was issued in the United States in June, 1900.

It is clear, in the case of any artificial reservoir, that without actually flooding the region in question dependence must be placed on one or both of two lines of research—the nature of the geological formation, and a comparison between the volume of water received from the clouds and that flowing to the sea by the watercourses. In the case of the Chagres valley, the geological examinations gave every promise that the water impounded would be retained with even less infiltration than usual; but, following their habit of neglecting nothing which could throw light upon the problem, the engineers of the New Company instituted what is perhaps the most elaborate study of the ratio between downfall and drainage that has yet been made in a valley like that of the Chagres above Bohio. The results, set forth in the following facts and figures, leave no doubt that the subsoil is fully saturated with water, and that no open route exists for any considerable subterranean escape.

The character of the general basin above Bohio, and of its three subdivisions, has already been described, and it only remains to consider the element of area entering the problem. The best map extant is one combining the surveys made for the Panama railroad with those for the canal, and covering the entire region with sufficient accuracy to define the dividing line separating it from the exterior watercourses except for a distance of about 35 miles on the northern and eastern portions of the upper basin. Here the limiting crest has never been traced, but a reconnaissance of the Chagres branch above its junction with the Pequeni made by a party of the Isthmian Canal Commission coming from the San Blas region, the notes of which were courteously communicated to the New Company, has enabled this gap to be approximately filled. Any error resulting from uncertainty as to the exact limits of this small portion of the boundary of the entire watershed can affect the computed ratios only so slightly as to have no influence on any general conclusions resulting from the study.

To determine the rainfall in the basin, daily observations have been made at Bohio, Gamboa, and Alhajuela, while those of the Panama Railroad at Colon may fairly be considered to represent what falls in the extreme upper part of the sub-basin, which so closely approaches the Atlantic coast as to be subjected to similar conditions. The following table exhibits the dimensions of the region in question. They indicate that it is not a violent assumption to consider that the average monthly rainfall in the lower sub-basin is measured by the mean of that noted at Bohio and Gamboa; that of the middle sub-basin, by the mean of that noted at Gamboa and Alhajuela; and that of the upper sub-basin, by the mean of the rain fall noted at Alhajuela and at Colon.

| Sub-basins. | Basin of the Chagres above Bohio. | | | | Length of bed, miles. | Number of affluents. |
|---|---|---|---|---|---|---|
| | Area in square miles. | Per cent. | Approx. length, miles. | Approx. width, miles. | | |
| Above Alhajuela........ | 320 | 46 | 18 | 16 | 31 | ? |
| Alhajuela-Gamboa ...... | 130 | 18 | 7 | 18 | 11 | 15 |
| Gamboa-Bohio .......... | 250 | 36 | 11 | 23 | 20 | 17 |
| Totals.............. | 700 | 100 | | | 70 | |

The general formula for computing the desired ratio for the entire basin, based upon the above assumptions and data, is the following, that for each sub-basin being easily derived therefrom. In it Q denotes the discharge in cubic metres per second at Bohio; D, the number of days considered; B, G, A, and C the corresponding rainfall at Bohio, Gamboa, Alhajuela and Colon, expressed in metres; and R the desired ratio for the days considered. The numerical coefficient of the denominator correlates the mile and metre units.

$$R = \frac{Q \times 3600 \times 24 \times D}{1610^2 \left( \frac{250(B+G)}{2} + \frac{130(G+A)}{2} + \frac{320(A+C)}{2} \right)}$$

For convenience the computations have been made for calendar months, which in general afford periods sufficiently long to eliminate errors resulting from the time elapsed between the precipitation and the outflow from the basin, which, as will appear below, varies in freshets from 24 to 48 hours. The manner of determining the bi-hourly discharges from which the values of Q result has been fully described above. It should be noted that the first rainfall observations at Alhajuela were made in June, 1899, and therefore that for earlier months it has been necessary to adopt the rainfall at Colon for the average in the upper sub-basin, modifying the formula accordingly. Comparisons of results thus computed with those of the later months when the rainfall at Alhajuela is known, have demonstrated that any errors induced in the desired ratio are very much too small to affect conclusions based on the general study.

Data have been collected to permit this investigation to cover the entire basin, the lower sub-basin, and the two upper sub-basins jointly, for a period of about five years; and to do the same but differentiating between the upper and middle sub-basins for four years. The numerical values of the ratio between downfall and drainage, thus computed, are presented for each month, except for May, 1902, when through a misunderstanding the observations were suspended.

| Month. | Above Bohio (5 years). | | | | | | Above Gamboa (5 years). | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1898 | 1899 | 1900 | 1901 | 1902 | Mns. | 1898 | 1899 | 1900 | 1901 | 1902 | Mns. |
| Jan. .... | 1.79 | 0.99 | 1.00 | 3.28 | 1.10 | 1.63 | 3.83 | 1.50 | 1.35 | 4.29 | 0.82 | 2.36 |
| Feb. .... | 6.33 | 0.67 | 7.13 | 2.50 | 6.89 | 4.70 | 14.52 | 5.36 | 11.12 | 3.98 | 8.96 | 8.79 |
| March .. | 1.72 | 0.97 | 3.50 | 0.81 | 1.04 | 1.61 | 3.33 | 1.88 | 3.06 | 0.77 | 1.59 | 2.13 |
| April ... | 0.75 | 1.66 | 0.39 | 0.53 | 0.54 | 0.77 | 1.48 | 2.83 | 0.50 | 0.60 | 0.83 | 1.25 |
| May .... | 0.47 | 0.32 | 0.29 | 0.30 | ... | 0.35 | 0.70 | 0.49 | 0.33 | 0.39 | ... | 0.48 |
| June .... | 0.48 | 0.55 | 0.30 | 0.42 | 0.70 | 0.49 | 0.12 | 0.96 | 0.33 | 0.43 | 0.90 | 0.55 |
| July .... | 0.48 | 0.41 | 0.54 | 0.47 | 0.47 | 0.47 | 0.29 | 0.42 | 0.48 | 0.64 | 0.58 | 0.48 |
| Aug. .... | 0.44 | 0.81 | 0.71 | 0.43 | 0.59 | 0.60 | 0.68 | 0.95 | 0.72 | 0.48 | 0.89 | 0.74 |
| Sept. ... | 0.66 | 0.58 | 0.59 | 0.64 | 0.59 | 0.61 | 0.88 | 0.66 | 0.57 | 0.67 | 0.69 | 0.69 |
| Oct. .... | 0.65 | 0.63 | 0.79 | 0.59 | | 0.67 | 0.88 | 0.70 | 0.82 | 0.54 | | 0.74 |
| Nov. .... | 0.84 | 0.77 | 0.65 | 0.83 | | 0.77 | 0.96 | 0.79 | 0.65 | 0.67 | | 0.77 |
| Dec. .... | 0.96 | 1.32 | 2.74 | 1.13 | | 1.54 | 1.14 | 1.50 | 3.18 | 1.51 | | 1.83 |

| Month | Upper sub-basin. | | | | | Middle sub-basin. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1899 | 1900 | 1901 | 1902 | Mns. | 1899 | 1900 | 1901 | 1902 | Mns. |
| Jan. ...... | 1.90 | 1.45 | 4.76 | 0.94 | 2.26 | 0.53 | 0.66 | 1.14 | 0.54 | 0.72 |
| Feb. ...... | 0.67 | 13.42 | 4.43 | 8.75 | 6.82 | 0.21 | * | * | 9.94 | 5.07 |
| March .... | 2.35 | 3.23 | 0.95 | 2.15 | 2.17 | 0.72 | * | * | 0.79 | 0.76 |
| April ..... | 3.32 | 0.81 | 0.80 | 1.17 | 1.52 | 1.64 | * | * | 0.13 | 0.89 |
| May ...... | 0.51 | 0.43 | 0.51 | ... | 0.48 | 0.25 | * | 0.14 | ... | 0.13 |
| June ..... | 0.99 | 0.37 | 0.52 | 0.87 | 0.69 | 0.36 | 0.23 | 0.28 | 0.79 | 0.42 |
| July ...... | 0.41 | 0.43 | 0.79 | 0.52 | 0.54 | 0.50 | 0.62 | 0.22 | 0.81 | 0.54 |
| August ... | 0.95 | 0.74 | 0.58 | 1.10 | 0.84 | 0.80 | 0.67 | 0.22 | 0.47 | 0.54 |
| Sept. ..... | 0.68 | 0.57 | 0.74 | 0.76 | 0.69 | 0.62 | 0.60 | 0.50 | 0.50 | 0.55 |
| Oct. ...... | 0.71 | 0.78 | 0.57 | | 0.69 | 0.59 | 0.91 | 0.46 | | 0.62 |
| Nov. ...... | 0.81 | 0.62 | 0.61 | | 0.68 | 0.72 | 0.78 | 0.84 | | 0.78 |
| Dec. ..... | 1.49 | 3.13 | 2.13 | | 2.25 | 1.51 | 3.57 | 0.16 | | 1.75 |

* No outflow from basin.

| Month. | Lower sub-basin. | | | | | |
|---|---|---|---|---|---|---|
| | 1898 | 1899 | 1900 | 1901 | 1902 | Means. |
| January ...................... | 0.82 | 2.26 | 0.48 | 2.15 | 1.55 | 1.45 |
| February ...................... | 1.28 | 1.04 | 3.27 | 1.40 | 3.96 | 2.19 |
| March ...................... | 0.22 | 0.07 | 1.71 | 0.88 | 0.44 | 0.66 |
| April ...................... | 0.12 | 0.02 | 0.21 | 0.36 | 0.28 | 0.20 |
| May ...................... | 0.10 | 0.07 | 0.18 | 0.18 | ... | 0.13 |
| June ...................... | 0.18 | 0.25 | 0.27 | 0.34 | 0.21 | 0.25 |
| July ...................... | 0.40 | 0.38 | 0.67 | 0.31 | 0.03 | 0.36 |
| August ...................... | 0.18 | 0.57 | 0.68 | 0.35 | 0.23 | 0.40 |
| September ...................... | 0.34 | 0.42 | 0.61 | 0.59 | 0.41 | 0.47 |
| October ...................... | 0.40 | 0.52 | 0.75 | 0.68 | | 0.59 |
| November ...................... | 0.65 | 0.73 | 0.64 | 1.11 | | 0.78 |
| December ...................... | 0.59 | 0.99 | 2.03 | 0.73 | | 1.09 |

On Figure 3 is shown each of the annual monthly means and the general curve for the five years at Bohio; and an examination of the tables will demonstrate that the sub-basins confirm the same conclusions. The ratio between downfall and drainage is subject to a regular monthly variation. The smallest value, about four-tenths, occurs about the middle of May, at the end of the dry season, or shortly thereafter. The ratio steadily increases until by the middle of November it becomes about eight-tenths. During the dry season it varies greatly, as should be expected, often exceeding unity and attaining its maximum value about February—demonstrating that at this season the greater part of the flow proceeds not from direct rainfall but from ground water. After February the supply begins to diminish, and the ratio falls rapidly to the minimum in May.

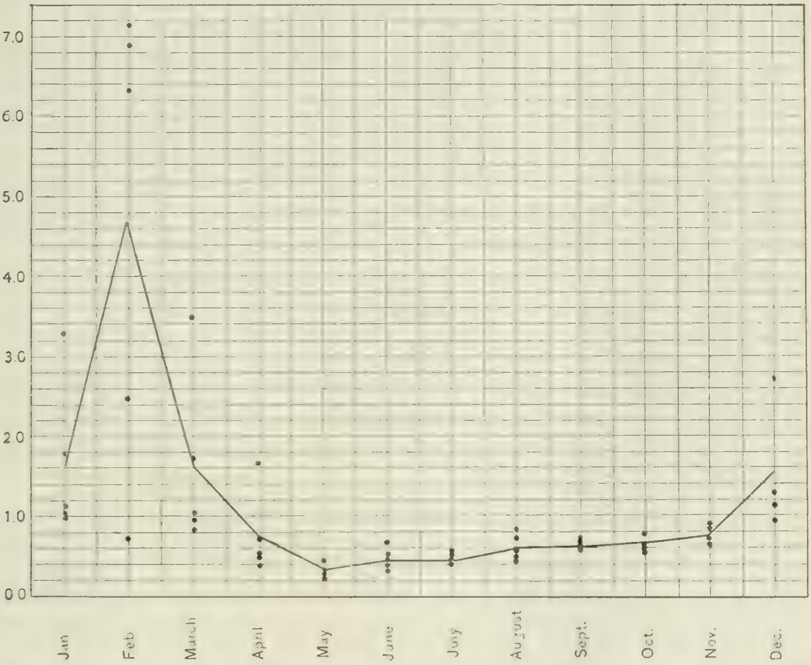


FIG. 3. RATIO BETWEEN DOWNFALL AND DRAINAGE IN THE BASIN OF THE CHAGRES ABOVE BOHIO.

**Full line represents mean of five years' observations. Dots indicate annual means. Values above unity are explained by reception of ground water.**

Although the variable nature of this ratio is well-known, depending on the character of the storms, whether violent or moderate, the condition of the soil as to geological formation and previous moisture, the nature and extent of the forest growth, and other local peculiarities, it is nevertheless not too much to assume that the concordant testimony of the entire valley and of its sub-divisions, shown by these figures, cannot be accidental but points to a general conclusion, to wit: the soil in this basin of the Chagres, covered with a dense tropical growth and subjected to sharply defined rainy and dry seasons, acts like a vast sponge to modify the flow of the river materially, and greatly to the advantage of the canal, since it causes a considerable discharge in the dry season. Further than this, the figures show that the soil to heights much exceeding any projected for the artificial lakes is saturated with water which gradually percolates to the bed of the river, and hence that there can be no reasonable apprehension of loss by subterranean outlets.

These conclusions are so interesting that the study will be pushed further, not with a view to deduce precise figures but simply to illustrate in a general manner the scale on which nature is working. Let an average annual value for the ratio between downfall and drainage be assumed—say five-tenths, which experience has shown to be nearly that for streams of this size and character, and which the above measurements show to be applicable to the Chagres itself when receiving no considerable volume of ground water. Upon this assumption the portion of each monthly discharge attributable to direct rainfall may be computed, since it is the product of the measured monthly discharge by the quotient obtained by dividing 0.5 by the observed value of the ratio for the month. The difference between this quantity and the measured monthly discharge will represent the volume received from the ground. The results of such a calculation applied to the entire valley above Bohio for the four complete years covered by observations (1898-1901) are the following:

| Month. | Measured ratio. | Measured discharge feet seconds. | Volume due to rainfall feet seconds. | Volume of ground water feet seconds. |
|---|---|---|---|---|
| January ........ | 1.76 | 3,284 | 918 | 2,366 |
| February ....... | 4.16 | 1,377 | 176 | 1,201 |
| March .......... | 1.50 | 883 | 283 | 600 |
| April ........... | 0.83 | 1,095 | 671 | 424 |
| May ........... | 0.35 | 2,154 | 2,154 | 000 |
| June ........... | 0.44 | 3,037 | 3,037 | 000 |
| July ............ | 0.48 | 4,838 | 4,838 | 000 |
| August ......... | 0.60 | 5,156 | 4,309 | 847 |
| September ...... | 0.62 | 4,521 | 3,638 | 883 |
| October ........ | 0.67 | 5,827 | 4,344 | 1,483 |
| November ...... | 0.77 | 8,264 | 5,474 | 2,790 |
| December ...... | 1.54 | 3,708 | 2,013 | 1,695 |
| Means ...... | | 3,679 | 2,655 | 1,024 |

Without wishing to place too high an estimate upon the numerical accuracy of these figures, it may be noted that the only months (August and December) which fail to show a progressive and natural variation in the volume indicated for ground water were both affected by conditions tending to produce the discrepancies. Thus exceptional freshets in August, 1899, probably made the assumed annual ratio too small for that month; and the very exceptional low water in December, 1898, probably made it too high. However that may be, it seems to be a legitimate conclusion that a very large portion of the annual discharge of the river, perhaps as much as one-fourth, and during the dry months even more than one-half, reached its bed as ground water. During the months of May, June, and July, or about three months after the rain had ceased, this supply was cut off, but only to begin again to filter through the springs and rivulets and gradually to increase until the maximum flow in November, December, and January. Such a regimen is certainly very fortunate for the canal, furnishing as it does a natural reserve to assist in supplying the needs of the dry season.

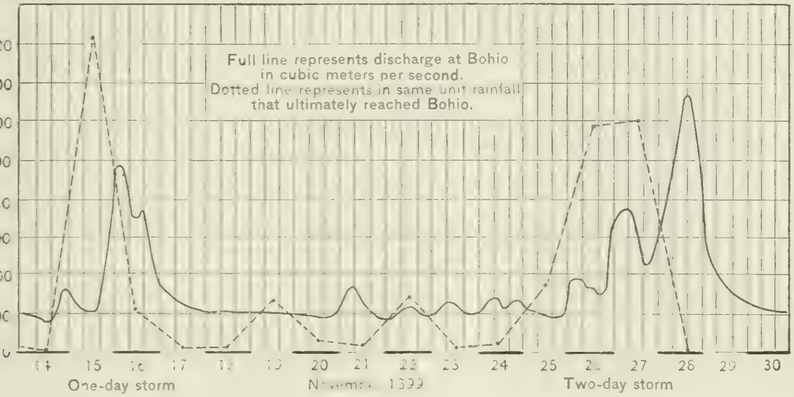


FIG. 4. RETARDATION OF RAINFALL BEFORE REACHING BOHIO.

Before leaving this subject of downfall and drainage it may be of interest to advert to another application which may be made of the analysis. Ignoring ground water, and assuming that the value of the ratio determined for each month is applicable to each day of it, it is easy to ascertain the time which elapses between the fall of the rain and its passage past Bohio in the bed of the river. By placing D in the last formula equal to unity, solving with respect to Q, and reducing, it may be put under the following form:

$$Q = 6750\, R\, (0.6\, B + 0.9\, G + A + 0.7\, C)$$

Substituting in the second member the measured mean value of R for the given month, and for each day the observed precipitation at the four stations in metres, the deduced daily values of Q will represent in cubic metres per second the volume of the daily rainfall that ultimately passed to the sea at Bohio. The sum of these volumes for the entire month will of course be identical with what was measured at Bohio. By platting each set of daily values and connecting them, the two curves will indicate to the eye the desired intervals of time between the fall from the clouds and the passage past Bohio.

With a view to obtain precise knowledge as to the interval of time of which use might be made, telegraphically, during critical periods in the construction of the dam at Bohio, such a daily study was made during an entire rainy season, and the retardation proved to vary from 24 to 48 hours, according to the locus of the heaviest downfall in the basin. Figure 4 has been added to illustrate the method, which made very apparent the influence exerted by the longer or shorter duration of the storms. One or two days will cause a considerable freshet, but the great floods come only with long continued downpours.

*Water Supply in the Dry Season.*—A precise and well grounded estimate of the contributions of the river that can be made available to serve the needs of the canal, either directly or by storage in suitable reservoirs, is even more important than a knowledge of the volumes carried in the great floods. Any mistake here might be productive of consequences too serions to be contemplated. The demands of the three dry months, February, March, and April, need only be considered, as during the remaining nine months the supply is ample to meet any possible demands.

As may be seen by reference to the second table in the Appendix, this tri-monthly discharge of the Chagres at Alhajuela was determined in 1895, 1896, 1899, 1900, 1901, and 1902, with much precision; but as it is desirable to know not only the absolute minimum volume in seasons of minimum flow, but also to extend the inquiry to cover as many years as possible in order to estimate the average supply, it seems important to make use of the still more numerous gaugings at Gamboa and Bohio to throw additional light on the question. This may be done by noting the relative discharge at the three stations, especially in the dry season when the river is a quiet stream, rarely or never disturbed by freshets, and when, therefore, the desired ratio is subject only to small variations. This comparison has been carefully made with the following results, which are based upon monthly measurements for five years as between Alhajuela and Gamboa and Bohio, and eight years as between Gamboa and Bohio. It will be noted that the discrepancies caused by the three missing years at Alhajuela are insignificant, thus confirming the trustworthiness of the percentages.

Volume at Alhajuela 84 per cent. of that at Gamboa in dry season, 78 per cent. in rainy season, and 80 per cent. annually.

Volume at Alhajuela 75 per cent. of that at Bohio in dry season, 55 per cent. in rainy season, and 60 per cent. annually.

Volume at Gamboa 83 per cent. of that at Bohio in dry season, 68 per cent. in rainy season, and 72 per cent. annually.

The following table exhibits the application of these ratios to the problem in hand, the unit being cubic feet per second.

| Year. | Measured tri monthly discharge. | | | Probable tri-monthly discharge at Alhajuela. | | |
|---|---|---|---|---|---|---|
| | Alhajuela. | Gamboa. | Bohio. | 84 per cent. of Gamboa. | 75 per cent. of Bohio. | Means. |
| 1890........ | .... | 1,165 | 1,427 | 978 | 1,069 | 1,024 |
| 1891........ | .... | 695 | 859 | 584 | 644 | 614 |
| 1892........ | .... | 1,377 | 1,672 | 1,156 | 1,254 | 1,205 |
| 1893........ | .... | 2,060 | 2,484 | 1,731 | 1,863 | 1,797 |
| 1894........ | .... | 1,107 | 1,224 | 930 | 918 | 924 |
| 1895........ | 977 | 1,236 | 1,165 | 1,038 | 874 | 956 |
| 1896........ | 973 | 1,038 | 1,377 | 871 | 1,033 | 952 |
| 1897........ | .... | 765 | 1,059 | 643 | 795 | 719 |
| 1898........ | .... | 1,448 | 1,601 | 1,217 | 1,201 | 1,209 |
| 1899........ | 860 | 989 | 1,271 | 831 | 953 | 892 |
| 1900........ | 636 | 636 | 836 | 534 | 627 | 580 |
| 1901........ | 530 | 530 | 753 | 445 | 565 | 505 |
| 1902........ | 1,259 | 1,519 | 1,836 | 1,276 | 1,377 | 1,326 |
| Means.... | 871 | 1,112 | 1,351 | 941 | 1,013 | 977 |

These close accordances between the discharges actually measured at Alhajuela and those deduced from the gaugings at both Gamboa and Bohio can leave no doubt that the final column of means in this table may be accepted as indicating with all requisite precision the volumes that have passed Alhajuela in the dry season during the past thirteen years, and hence affords a trustworthy basis for estimating the shortage to be supplied by reserves in the reservoir lake. It appears that the minimum flow during the three dry months may safely be estimated as at least 500 cubic feet per second. The figure accepted in the estimates of the *Comité Technique*, adopted before 1901 (the year of minimum flow) was 16 cubic metres or 565 cubic feet. The volume usually delivered by the river will evidently be about 1,000 cubic feet.

In connection with the water supply another important element remains to be considered. It may be assumed that with the lapse of years the traffic will call for the daily passage of the largest number of vessels that can mechanically be accommodated—say twenty-four convoys moving in one or the other direction, having an average tonnage of 3,000 tons and serving the needs of an annual traffic of about 23,000,000 tons, which is nearly triple that of the Suez canal. Under such conditions will the portion of the annual volume carried by the Chagres and that can be conserved in the lake at Alhajuela then be adequate to meet the demands during the ninety days of the dry season, the natural flow of the river being ample at other times to meet all possible needs? This question involves not only the capacity that can be given to the projected lake, but also the volume which the river can be trusted to supply during the entire year. The latter element calls for a knowledge of the minimum quantity passing annually at

Alhajuela, which can be estimated from the records of the past twelve years by a computation similar to the above. The following table presents the figures in cubic feet per second.

| Year. | Measured annual discharge. | | | Probable annual discharge at Alhajuela. | | |
|---|---|---|---|---|---|---|
| | Alhajuela. | Gamboa. | Bohio. | 80 per cent. of Gamboa. | 60 per cent. of Bohio. | Means. |
| 1890........ | .... | 4,175 | 6,088 | 3,340 | 3,653 | 3,437 |
| 1891........ | .... | 3,045 | 4,141 | 2,436 | 2,485 | 2,460 |
| 1892........ | .... | 4,314 | 6,257 | 3,451 | 3,754 | 3,603 |
| 1893........ | .... | 3,605 | 7,072 | 2,884 | 4,243 | 3,563 |
| 1894........ | .... | 3,773 | 6,098 | 3,018 | 3,659 | 3,338 |
| 1895........ | 2,169 | 3,055 | 4,490 | 2,444 | 2,694 | 2,569 |
| 1896........ | 2,107 | 2,743 | 4,214 | 2,194 | 2,528 | 2,361 |
| 1897........ | .... | 2,864 | 4,830 | 2,291 | 2,898 | 2,594 |
| 1898........ | .... | 2,979 | 3,943 | 2,383 | 2,366 | 2,374 |
| 1899........ | 2,105 | 2,572 | 3,384 | 2,058 | 2,030 | 2,044 |
| 1900........ | 1,836 | 2,345 | 3,508 | 1,876 | 2,105 | 1,990 |
| 1901........ | 1,981 | 2,393 | 3,855 | 1,914 | 2,333 | 2,124 |
| Means.... | 2,040 | 3,155 | 4,823 | 2,524 | 2,896 | 2,710 |

A comparison of the discharges actually measured at Alhajuela with those deduced from the gaugings at Gamboa shows a remarkable accordance, and certainly warrants the adoption of the values for the missing years as shown in the fifth column. The values deduced at Bohio, 20 miles below, although slightly larger, serve to confirm the same practical conclusions. The average annual discharge at Alhajuela considerably exceeds 2,000 cubic feet per second, and has never fallen below 1,800 cubic feet there since we have knowledge of the river. It remains to form an estimate of the volume of water required for the operation of the canal.

Two epochs will be considered: First, assuming the traffic which may be anticipated during the early years after the opening, say 10,000,000 tons, requiring the passage daily for 320 days annually of ten convoys moving in one or the other direction, each having an average tonnage of 3,000 tons; second, when the full capacity of the canal as projected is attained, calling for twenty-four such transits in one or the other direction, and yielding a traffic of about 23,000,000 tons.

Until the dimensions of the locks are finally fixed, which can hardly be considered the case at present, the computations must remain subject to revision; but, as will appear below, moderate changes in these dimensions will affect the total volume of water required in so small a percentage as to be negligible in a general study. For this reason it has appeared better to present the definite figures of the projet formulated by the *Comité Technique* rather than to introduce uncertain modifications. This projet was based on the probable commercial requirements of the canal for the next fifty years, after extensive correspondence with leading shippers and ship-builders.

The volume of the lockages for a passage through the canal may be estimated from the general formula, applied to each slope, in which N denotes the largest number of locks in flight and V the corresponding largest water prism:

$$\text{Total lockages on slope} = \frac{N + 2}{4} V$$

The other elements of the problem, all of which are independent of the traffic and nearly so of the dimensions of the locks, will be considered in turn. Evaporation at all exposed water surfaces was assumed at 6 millimetres (0.24 inches) per 24 hours. Loss by infiltration was allowed the same volume, although as has been shown above there is little probability of any important escape. The lighting of the canal, the manœuvres of lock gates, and the aid to shipping in the passage, are all to be effected by taking advantage of the artificial fall of about 46 metres (151 feet) at the dam at Alhajuela and at the locks at Bohio. In this manner about 4,300 horse power will be available, which by the agency of turbines and dynamos may be transferred electrically to the desired points of application with a loss not exceeding 50 per cent., thus furnishing an ample supply for all needs. The following table exhibits the continuous water flow per second required.

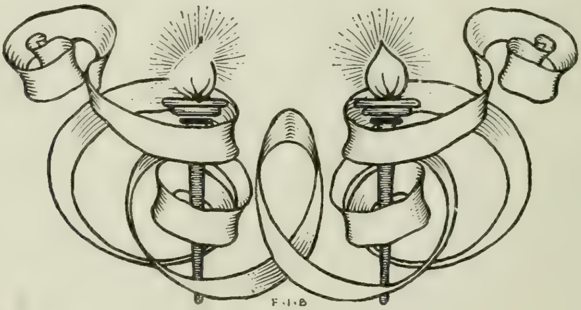
| Requirements. | Traffic of 10,000,000 tons. | | Traffic of 23,000,000 tons. | |
|---|---|---|---|---|
| | Cubic metres. | Cubic feet. | Cubic metres. | Cubic feet. |
| For lockages | 10 | 353 | 24 | 848 |
| For leakages at gates | 3 | 106 | 3 | 106 |
| Evaporation and infiltration | 5 | 167 | 5 | 177 |
| False manœuvres | 2 | 71 | 2 | 71 |
| Lighting and motive power | 7 | 247 | 7 | 247 |
| General contingencies | 8 | 283 | 8 | 283 |
| Total | 35 | 1.237 | 49 | 1,732 |

Deducting from these totals the volume which the river itself will contribute during the ninety days of lowest water, say 500 cubic feet per second, the needful storage capacity to be provided in the lake can readily be computed. The site at Alhajuela is exceptionally favorable, as will appear from the following summary of the projet of the New Company. The dam is to be of masonry, founded on and abutting against good rock. The following heights refer to mean sea level as zero: foundation, 19 metres or 62 feet; crest, 70 metres, or 230 feet; minimum lake level, 58 metres or 190 feet; level of low-water reserves, 65 metres or 213 feet; maximum lake level, 68 metres or 223 feet. These dimensions furnish a capacity for low-water reserves of 170,000,000 cubic metres (154,000 acre feet) and for flood reserves of 100,000,000 cubic metres (81,100 acre feet). Furthermore the dam is planned to admit of increased height, either at first or at any future time, permitting increased reserves at the rate of 30,000,000 cubic metres per metre of rise.

In fine, a comparison of these demands for low-water supply with the above tabulated statement showing the annual discharge of the Chagres at Alhajuela, will make apparent the fact that the river is marvelously well adapted to meet the needs of the canal. It supplies all the water that can ever be demanded by any probable traffic for centuries to come, and yet with judicious regulation no annoyance from currents will ever be experienced by shipping on any part of the route. Nothing better could be desired to subserve the object in view. Far from being a menace, the Chagres is a most useful friend.

The contrast is striking when a comparison is made with the conditions existing in Nicaragua where, for a distance greater than the whole length of the canal in Panama, shipping in transit must contend in the crooked San Juan river, swept by strong trade winds, with currents due to the entire drainage of a region 12,000 square miles in extent, where even the possibility of passage is dependent on skilful and accurate regulation of the level of a vast lake covering 3,000 square miles, for which no reserves can be provided, where the only outlet is 50 miles distant, and where the natural level is subject to considerable oscillations varying from month to month and from year to year. The question of water supply alone should be sufficient to decide the choice between the two routes. One is certain and sure; the other cannot but be subject to frequent and costly delays in transit.

The Appendices to General Abbot's paper will be found on the next two pages.



## APPENDIX, TABLE I.

Number and Duration of Rises at Gamboa Exceeding 10 Feet Above Low-Water Stage, the Greatest Height in Feet Above Low Water, and Local Rainfall in Inches.

| | January. | | | | February. | | | | March. | | | | April. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year. | Rises. | Hours. | Feet. | Rain. | Rises. | Hours. | Feet. | Rain. | Rises. | Hours. | Feet. | Rain. | Rises. | Hours. | Feet. | Rain. |
| 1882.. | .. | .. | ... | ... | .. | .. | ... | ... | .. | .. | ... | 0.5 | .. | .. | ... | 1.5 |
| 1883.. | 0 | 0 | 7.3 | ... | 0 | 0 | 2.3 | ... | 0 | 0 | 2.0 | ... | 0 | 0 | 3.1 | 2.6 |
| 1884.. | 0 | 0 | 5.7 | ... | 0 | 0 | 3.3 | 0.7 | 0 | 0 | 2.4 | 0.3 | 2 | 9 | 12.6 | 6.5 |
| 1885.. | 0 | 0 | 3.3 | 0.2 | 0 | 0 | 3.1 | 0.2 | 0 | 0 | 2.9 | 0.0 | 0 | 0 | 3.9 | 1.4 |
| 1886.. | 0 | 0 | 7.3 | 0.5 | 0 | 0 | 4.8 | 1.1 | 1 | 9 | 12.8 | 0.7 | 0 | 0 | 8.2 | 2.8 |
| 1887.. | 0 | 0 | 8.2 | 2.2 | 0 | 0 | 4.9 | 0.1 | 0 | 0 | 3.9 | 0.3 | 0 | 0 | 3.6 | 6.8 |
| 1888.. | 0 | 0 | 5.1 | 0.1 | 0 | 0 | 3.3 | 0.6 | 0 | 0 | 3.0 | 0.4 | 1 | 10 | 13.1 | 1.3 |
| 1890.. | 0 | 0 | 9.1 | 4.1 | 0 | 0 | less | 0.3 | 0 | 0 | less | 2.4 | 0 | 0 | 6.3 | 3.0 |
| 1891.. | 0 | 0 | less | 0.6 | 0 | 0 | less | 0.0 | 0 | 0 | less | 0.3 | 0 | 0 | less | 2.1 |
| 1892.. | 0 | 0 | less | 1.1 | 0 | 0 | less | 0.7 | 0 | 0 | less | 2.6 | 0 | 0 | less | 4.7 |
| 1893.. | 0 | 0 | 3.0 | 0.7 | 0 | 0 | 3.6 | 1.1 | 0 | 0 | 6.3 | 0.7 | 2 | 27 | 16.3 | 7.4 |
| 1894.. | 2 | 25 | 17.9 | 1.5 | 0 | 0 | 2.2 | 0.2 | 0 | 0 | 1.0 | 0.1 | 0 | 0 | 2.4 | 1.3 |
| 1895.. | 1 | 2 | 10.3 | ... | 0 | 0 | 2.4 | ... | 0 | 0 | 2.3 | ... | 1 | 1 | 10.0 | ... |
| 1896.. | 0 | 0 | 4.9 | ... | 0 | 0 | less | ... | 0 | 0 | less | ... | 0 | 0 | 8.5 | ... |
| 1897.. | 0 | 0 | 7.2 | ... | 0 | 0 | less | 0.2 | 0 | 0 | less | 0.3 | 1 | 3 | 10.2 | 3.2 |
| 1898.. | 2 | 22 | 17.0 | 2.8 | 0 | 0 | 2.0 | 0.1 | 0 | 0 | 1.6 | 0.0 | 1 | 16 | 17.7 | 1.4 |
| 1899.. | 2 | 29 | 14.2 | 5.0 | 0 | 0 | less | 1.7 | 0 | 0 | less | 1.3 | 0 | 0 | 5.3 | 1.4 |
| 1900.. | 0 | 0 | 8.9 | 1.0 | 0 | 0 | 1.4 | 0.2 | 0 | 0 | 0.2 | 0.1 | 0 | 0 | 6.3 | 3.2 |
| 1901.. | 0 | 0 | 3.2 | 0.4 | 0 | 0 | 2.4 | 0.2 | 0 | 0 | 1.0 | 0.2 | 0 | 0 | 2.3 | 0.8 |
| 1902.. | 3 | 57 | 16.4 | 13.4 | 0 | 0 | 2.2 | 0.2 | 0 | 0 | 0.9 | 4.4 | 1 | 5 | 11.2 | 9.5 |
| Means | 0.5 | 7 | 8.8 | 2.4 | 0 | 0 | 2.9 | 0.5 | 0.1 | 0.5 | 3.1 | 0.9 | 0.5 | 4 | 8.3 | 3.4 |

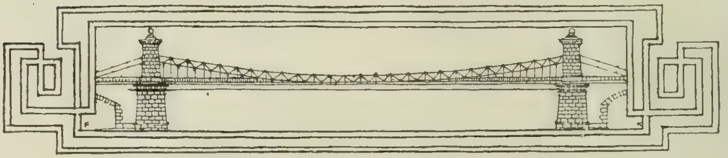
| | May. | | | | June. | | | | July. | | | | August. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1882.. | .. | .. | ... | 15.5 | .. | .. | ... | 6.3 | .. | .. | ... | 10.1 | .. | .. | ... | 9.9 |
| 1883.. | 1 | 10 | 16.7 | 9.7 | 2 | 14 | 14.1 | 11.0 | 4 | 37 | 16.7 | 6.5 | 5 | 43 | 13.8 | 15.9 |
| 1884.. | 3 | 137 | 16.1 | 6.2 | 5 | 29 | 16.7 | 13.4 | 4 | 49 | 17.7 | 9.6 | 3 | 25 | 15.1 | 16.5 |
| 1885.. | 0 | 0 | 5.9 | 11.1 | 1 | 2 | 10.2 | 10.4 | 6 | 41 | 16.4 | 9.1 | 8 | 66 | 18.0 | 15.5 |
| 1886.. | 0 | 0 | 9.5 | 15.7 | 2 | 10 | 11.8 | 10.6 | 5 | 31 | 15.1 | 11.7 | 5 | 28 | 11.8 | 16.4 |
| 1887.. | 6 | 54 | 16.1 | 11.0 | 11 | 108 | 24.0 | 19.5 | 3 | 21 | 15.4 | 14.0 | 11 | 130 | 16.4 | 19.2 |
| 1888.. | 0 | 0 | 8.2 | 20.5 | 6 | 43 | 14.8 | 11.9 | 0 | 0 | less | 3.3 | 1 | 7 | 12.2 | 10.2 |
| 1890.. | 5 | 44 | 13.8 | 13.3 | 4 | 26 | 13.1 | 11.7 | 4 | 34 | 14.8 | 10.4 | 7 | 45 | 13.1 | 15.4 |
| 1891.. | 2 | 15 | 14.1 | 7.5 | 1 | 10 | 14.8 | 9.3 | 2 | 18 | 16.1 | 6.1 | 0 | 0 | less | 8.5 |
| 1892.. | 7 | 49 | 17.4 | 16.8 | 1 | 6 | 12.1 | 8.5 | 8 | 65 | 16.7 | 14.0 | 3 | 28 | 16.1 | 14.3 |
| 1893.. | 2 | 23 | 16.4 | 11.9 | 0 | 0 | 5.9 | 10.7 | 1 | 5 | 11.8 | 15.9 | 2 | 13 | 13.9 | 8.0 |
| 1894.. | 1 | 5 | 10.9 | 10.9 | 0 | 0 | 6.9 | 8.8 | 4 | 26 | 13.8 | 10.1 | 2 | 9 | 11.8 | 8.4 |
| 1895.. | 0 | 0 | 2.3 | ... | 1 | 12 | 15.9 | ... | 1 | 13 | 13.7 | ... | 2 | 6 | 12.9 | ... |
| 1896.. | .. | .. | ... | 3.4 | .. | .. | ... | 3.3 | .. | .. | ... | 5.8 | .. | .. | ... | ... |
| 1897.. | 6 | 96 | 23.0 | 17.4 | 0 | 0 | 8.9 | 12.6 | 0 | 0 | 9.7 | 9.1 | .. | .. | ... | 17.2 |
| 1898.. | 0 | 0 | 7.5 | 5.3 | 0 | 0 | 8.6 | 4.7 | 1 | 7 | 12.6 | 18.4 | 2 | 6 | 10.3 | 20.1 |
| 1899.. | 2 | 15 | 13.5 | 8.5 | 1 | 2 | 10.1 | 8.8 | 1 | 1 | 10.1 | 9.5 | 2 | 23 | 16.2 | 11.0 |
| 1900.. | 0 | 0 | 9.1 | 6.8 | 0 | 0 | 7.5 | 12.2 | 2 | 12 | 11.6 | 13.4 | 3 | 16 | 13.5 | 8.9 |
| 1901.. | 1 | 8 | 13.4 | 10.9 | 1 | 1 | 10.1 | 7.7 | 0 | 0 | 8.2 | 9.2 | 2 | 5 | 10.3 | 13.9 |
| 1902.. | .. | .. | ... | ... | 0 | 0 | 6.4 | 6.3 | 1 | 1 | 10.1 | 6.3 | 1 | 10 | 15.1 | 8.3 |
| Means | 2.1 | 27 | 12.6 | 11.2 | 2 | 15 | 11.8 | 9.9 | 2.6 | 20 | 13.6 | 10.1 | 3.5 | 27 | 13.8 | 13.2 |

| | September. | | | | October. | | | | November. | | | | December. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1882.. | .. | .. | ... | 11.8 | .. | .. | ... | 8.2 | 8 | 104 | 18.4 | 11.8 | 0 | 0 | less | 1.4 |
| 1883.. | 4 | 53 | 14.1 | 4.1 | 1 | 2 | 10.2 | 10.0 | 1 | 10 | 11.8 | 7.0 | 3 | 32 | 15.4 | 6.3 |
| 1884.. | 3 | 21 | 13.8 | 10.5 | 5 | 42 | 15.4 | 22.4 | 2 | 31 | 19.0 | 6.2 | 0 | 0 | 6.9 | 2.2 |
| 1885.. | 7 | 67 | 18.0 | 16.1 | 6 | 54 | 11.8 | 9.3 | 2 | 52 | 31.5 | 13.2 | 7 | 155 | 23.9 | 11.0 |
| 1886.. | 5 | 48 | 15.1 | 9.1 | 9 | 92 | 15.4 | 13.6 | 13 | 156 | 17.1 | 16.1 | 4 | 72 | 15.8 | 4.6 |
| 1887.. | 2 | 55 | 23.3 | 11.5 | .. | .. | ... | 14.9 | 4 | 154 | 18.7 | 24.1 | 2 | 127 | 15.4 | 12.7 |
| 1888.. | 10 | 78 | 15.4 | 12.3 | 5 | 27 | 12.5 | 9.6 | 3 | 20 | 10.5 | 16.2 | 4 | 424 | 31.4 | 16.3 |
| 1890.. | 3 | 27 | 16.1 | 8.9 | 5 | 49 | 17.4 | 21.4 | 3 | 30 | 16.1 | 9.9 | 3 | 53 | 31.8 | 4.3 |
| 1891.. | 0 | 0 | less | 10.5 | 1 | 1 | 10.2 | 15.7 | 2 | 54 | 19.7 | 10.7 | 2 | 18 | 12.8 | 6.4 |
| 1892.. | 0 | 0 | 6.9 | 13.7 | 2 | 17 | 13.1 | 11.1 | 1 | 30 | 22.8 | 10.2 | 2 | 74 | 15.8 | 6.6 |
| 1893.. | 0 | 0 | 9.2 | 10.2 | 0 | 0 | 8.9 | 16.5 | 1 | 9 | 13.1 | 13.9 | 6 | 170 | 25.3 | 20.9 |
| 1894.. | 3 | 20 | 13.9 | 15.2 | 3 | 19 | 12.5 | 15.3 | 5 | 35 | 14.1 | 10.7 | 7 | 149 | 19.0 | 8.3 |
| 1895.. | 0 | 0 | 8.9 | ... | 2 | 22 | 17.1 | ... | 0 | 0 | 8.5 | ... | 1 | 1 | 10.0 | ... |
| 1896.. | .. | .. | ... | ... | .. | .. | ... | ... | .. | .. | ... | ... | 1 | 15 | 13.3 | ... |
| 1897.. | .. | .. | ... | 18.8 | 1 | 2 | 10.2 | 12.8 | 3 | 16 | 12.7 | 5.0 | 4 | 37 | 13.2 | 8.6 |
| 1898.. | 0 | 0 | 5.6 | 4.1 | 2 | 13 | 13.7 | 8.7 | 3 | 25 | 16.9 | 14.6 | 0 | 0 | 4.5 | 2.4 |
| 1899.. | 0 | 0 | 8.6 | 13.5 | 0 | 0 | 9.8 | 8.0 | 2 | 16 | 14.8 | 8.7 | 0 | 0 | 9.4 | 2.7 |
| 1900.. | 1 | 4 | 11.2 | 9.3 | 3 | 24 | 15.1 | 12.1 | 2 | 14 | 11.9 | 10.7 | 1 | 14 | 14.1 | 0.8 |
| 1901.. | 1 | 6 | 11.7 | 8.4 | 0 | 0 | 9.5 | 14.1 | 7 | 73 | 20.9 | 19.1 | 1 | 14 | 15.4 | 6.7 |
| 1902.. | .. | .. | ... | ... | .. | .. | ... | ... | .. | .. | ... | ... | .. | . | ... | ... |
| Means | 2.3 | 23 | 11.8 | 10.9 | 2.8 | 23 | 12.7 | 13.2 | 3.4 | 46 | 16.6 | 12.3 | 2.5 | 71 | 15.5 | 7.2 |

## APPENDIX, TABLE 2.

MEAN MONTHLY DISCHARGE OF THE CHAGRES IN CUBIC FEET PER SECOND.

| Month | 1890 | 1891 | 1892 | 1893 | 1894 | 1895 | 1896 | 1897 | 1898 | 1899 | 1900 | 1901 | 1902 | Mn. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | AT ALHAJUELA. | | | | | | | | |
| Jan. | .... | .... | .... | .... | .... | 3214 | 2437 | .... | .... | 3178 | 1589 | 989 | 4238 | 2608 |
| Feb. | .... | .... | .... | .... | .... | 1095 | 1059 | .... | .... | 848 | 812 | 671 | 1271 | 959 |
| March | .... | .... | .... | .... | .... | 742 | 600 | .... | .... | 848 | 530 | 459 | 812 | 665 |
| April | .... | .... | .... | .... | .... | 1095 | 1271 | .... | .... | 883 | 565 | 459 | 1695 | 995 |
| May | .... | .... | .... | .... | .... | 1483 | 2543 | .... | .... | 1589 | 1342 | 1554 | 1702 | 1702 |
| June | .... | .... | .... | .... | .... | 2048 | 2225 | .... | .... | 2154 | 1554 | 1731 | 2190 | 1984 |
| July | .... | .... | .... | .... | .... | 1801 | 2366 | .... | .... | 2225 | 2190 | 1978 | 2119 | 2113 |
| Aug. | .... | .... | .... | .... | .... | 2543 | 2154 | .... | .... | 3284 | 2825 | 2437 | 2331 | 2596 |
| Sept. | .... | .... | .... | .... | .... | 1907 | 2154 | .... | .... | 2402 | 2154 | 2931 | 2336 | 2320 |
| Oct. | .... | .... | .... | .... | .... | 3638 | 2048 | .... | .... | 2649 | 3214 | 2755 | .... | 2861 |
| Nov. | .... | .... | .... | .... | .... | 2543 | 2472 | .... | .... | 2931 | 2967 | 4768 | .... | 3136 |
| Dec. | .... | .... | .... | .... | .... | 3920 | 3956 | .... | .... | 2260 | 2296 | 3037 | .... | 3094 |
| Means | .... | .... | .... | .... | .... | 2169 | 2107 | .... | .... | 2105 | 1836 | 1981 | .... | 2086 |
| | | | | | | AT GAMBOA. | | | | | | | | |
| Jan. | 2737 | 2048 | 1519 | 2296 | 3708 | 3532 | 2225 | 1766 | 4309 | 3496 | 1695 | 1024 | 5227 | 2737 |
| Feb. | 1342 | 954 | 1095 | 2013 | 1625 | 1483 | 1130 | 1130 | 1483 | 954 | 812 | 671 | 1589 | 1252 |
| March | 1095 | 600 | 989 | 1236 | 954 | 1095 | 636 | 494 | 1024 | 954 | 530 | 459 | 1024 | 853 |
| April | 1060 | 530 | 2048 | 2931 | 742 | 1130 | 1342 | 671 | 1836 | 1059 | 565 | 459 | 1942 | 1255 |
| May | 4274 | 3461 | 5510 | 3037 | 1377 | 3461 | 4450 | 3284 | 2472 | 1907 | 1342 | 1766 | 3028 | 3028 |
| June | 5333 | 2366 | 3496 | 3214 | 2225 | 3178 | 4132 | 2366 | 2861 | 2472 | 1942 | 2048 | 2896 | 2964 |
| July | 5404 | 3779 | 7416 | 3567 | 4450 | 3073 | 2931 | 3779 | 4238 | 2825 | 3355 | 2190 | 3002 | 3847 |
| Aug. | 5686 | 2790 | 6074 | 4732 | 3885 | 4061 | 2331 | 4097 | 4132 | 4238 | 3567 | 2861 | 2790 | 3942 |
| Sept. | 6816 | 3037 | 4379 | 3885 | 4450 | 3390 | 2719 | 3850 | 2543 | 3178 | 3073 | 3638 | 2931 | 3684 |
| Oct. | 6499 | 4450 | 5933 | 3744 | 4697 | 4944 | 2684 | 3850 | 3461 | 3390 | 4520 | 3708 | .... | 4323 |
| Nov. | 3956 | 7488 | 7240 | 4556 | 6533 | 3532 | 3214 | 4450 | 5192 | 3744 | 4061 | 6745 | .... | 5059 |
| Dec. | 5898 | 4044 | 6075 | 8052 | 10630 | 3779 | 5121 | 4626 | 2296 | 2649 | 2684 | 3143 | .... | 4916 |
| Means | 4175 | 3045 | 4314 | 3605 | 3773 | 3055 | 2743 | 2864 | 2979 | 2572 | 2345 | 2393 | .... | 3155 |
| | | | | | | AT BOHIO. | | | | | | | | |
| Jan. | 4253 | 2684 | 2225 | 3390 | 7063 | 4556 | 4732 | 2048 | 5651 | 3849 | 2119 | 1483 | 11231 | 4253 |
| Feb. | 1625 | 1377 | 1307 | 2437 | 1801 | 1377 | 1554 | 1589 | 1695 | 1731 | 1059 | 989 | 2084 | 1587 |
| March | 1307 | 600 | 1236 | 1483 | 1095 | 1059 | 883 | 706 | 1095 | 989 | 742 | 706 | 1271 | 1013 |
| April | 1342 | 600 | 2472 | 3532 | 777 | 1059 | 1695 | 883 | 2013 | 1095 | 706 | 565 | 2154 | 1453 |
| May | 6286 | 2366 | 8087 | 4450 | 3355 | 4167 | 4944 | 7981 | 2684 | 2048 | 1625 | 2296 | 4191 | 4191 |
| June | 7840 | 3214 | 5156 | 4944 | 4273 | 4310 | 4203 | 4203 | 3355 | 3143 | 2860 | 2790 | 3178 | 4113 |
| July | 7946 | 4803 | 10913 | 7628 | 6216 | 4591 | 3143 | 5121 | 6569 | 3955 | 5615 | 3178 | 3073 | 5596 |
| Aug. | 8371 | 4520 | 8935 | 10772 | 6498 | 6922 | 3496 | 7275 | 5298 | 5721 | 5262 | 4309 | 3390 | 6213 |
| Sept. | 10030 | 4450 | 6428 | 7664 | 7452 | 5792 | 5933 | 6887 | 3214 | 4238 | 4768 | 5792 | 2931 | 5890 |
| Oct. | 9571 | 6534 | 8723 | 8582 | 9359 | 6922 | 6357 | 7487 | 5050 | 4944 | 6993 | 6322 | .... | 7237 |
| Nov. | 5827 | 11019 | 10666 | 11443 | 12714 | 6074 | 7593 | 6057 | 7840 | 5297 | 6604 | 13244 | .... | 8773 |
| Dec. | 8653 | 7522 | 8935 | 18541 | 12573 | 6957 | 6039 | 6816 | 2861 | 3602 | 3744 | 4591 | .... | 7570 |
| Means | 6088 | 4141 | 6257 | 7072 | 6098 | 4490 | 4214 | 4830 | 3943 | 3384 | 3508 | 3855 | .... | 4824 |



# FOUNDRY MANAGEMENT IN THE NEW CENTURY.

*By Robert Buchanan.*

## I.—THE ECONOMICAL PRODUCTION OF CASTINGS.

With this article, Mr. Buchanan begins a systematic review of the best foundry practice which, in its complete extent, will survey the entire field of equipment and management. The paper in our next issue will consider "Crane Service for the Foundry Floor," with the aid of many illustrations of actual installations.—The Editors.

IN the advance towards better and more exact methods of production which has marked the past few years, no branch of engineering has had less attention bestowed upon it than the foundry. Those who have had to do with foundries and with foundry work have long ceased to be impressed with the inconsistency in the measure of treatment and consideration extended to the foundry, as compared with that given to departments using the foundry products.

I believe this neglect does not proceed altogether from indifference to the provision of suitable conditions. It probably arises in part from the fact that the employers and heads of firms, themselves not being trained foundry men, are in doubt as to the best methods to adopt for the production of castings by means at once economical and productive of good working conditions for the men employed in the work. The innate conservatism of the men practically engaged in foundry work has had results confirmatory of the attitude of those holding control, and so the lamentable results of doubt in the governing body, on the one hand, and the leave-well-alone policy on the other, are visible in many works today.

The want of progress in methods of production and in the ideas governing methods of production must also be ascribed in great part to the class of men too often placed in charge of foundries. The foundry has been too often the dumping ground for the failures and incompetents for whom places had to be found somewhere. This was and is done, all forgetful of the fact that there is almost no position whatever in which ignorance of the business is so easily found out, or in which the interference of the untrained and incompetent can work such havoc and cause such loss, as in the foundry.

SECTION OF FOUNDRY OF THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

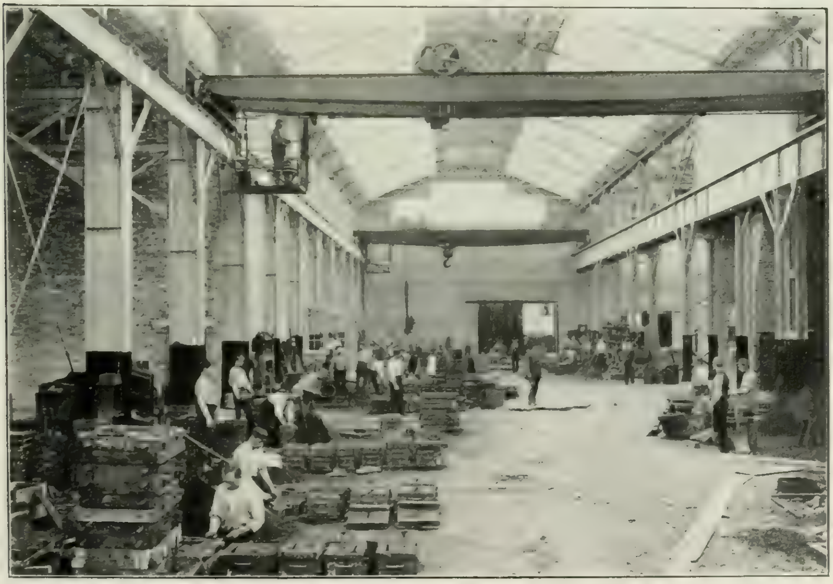
I have heard the managing director of a great engineering firm say that he made many improvements in the foundry of the company under his control by approaching the consideration of the matter with a mind unbiased by any previously formed ideas and prejudices, and that it was these same prejudices in the foundry people which had formed the greatest obstacles to the making of improvements. This is an instance of a keen intellect, sharpened by successful and effective control of other branches of engineering, making its impress upon the foundry by the very freshness of the ideas brought to bear upon the subject. Such an example is to be welcomed when accompanied by such powers, but the rarity of the example only serves to bring into greater prominence the necessity of applying to foundries the same rule of special training for the work which applies to all other branches of engineering.

It may be said that the conditions mentioned have arisen in the past, not from any desire to avoid employing men with foundry training in the most responsible positions, but for the reason that the supply of such men was inadequate to the demand. That there is ample room for improvement by those engaged in the business there is no gainsaying, though one may take leave to doubt, if, in the past, the rewards offered have been such as to induce the best class of men to engage in the work. When we come to consider the foundry as if it were in itself a machine for the regular and economical production of castings, the necessity of special training for those having control of the machines will be apparent.

The foundry as it ought to be would be in many ways the antithesis of what in too many cases it is now. The present condition of many foundries is too hopeless a theme to warrant the waste of either words or regrets. Let us leave them to the benign influence of time, and to the decay which has marked them for its own.

In considering what a foundry ought to be, if it is to fulfil its function in the highest degree, the test to apply to any part of the whole is to question in how far each thing under consideration is lending its influence in the right direction for the cheap production of finished goods. Whether the foundry be selling to outside firms or is only a department of a works which absorbs the whole of the output, the value of the castings produced will be greatly enhanced or depreciated by the facility or otherwise with which they may be worked up into the finished machine.

The tendency is for firms using castings made in their own foundries to demand the production of a quality which lends itself to being economically and rapidly machined, rather than the saving of a few pence or shillings in the mixture of metal used. To foundries selling



CRANE ARRANGEMENT IN THE FOUNDRY OF LUDWIG LOEWE & CO., BERLIN.

to outside firms the cost of mixtures is of greater immediate moment, any advantage from easy machining not reaching the pockets of the foundry men, at least directly, as a result of savings in time, tools, and cutters. It is to be hoped, however, that good work in either case meets with its just reward. With the difference mentioned, both kinds of foundries may be considered as having the one end in view.

It is not my intention to set out an ideal foundry to be run by ideal people, but to consider as fully as is practicable some of the things which will be profitable to know—things which are of the most practical character. To set down in plan and elevation a foundry which would look very nice would not be difficult. That it would profit any one is doubtful. The requirements of each firm engaged in making castings are so varied that we must content ourselves with a consideration of some of the component parts which help to make up the machine for producing castings which we call a foundry.

POURING FROM CRANE-CARRIED LADLES, FOUNDRY OF THE DEUTSCHE NILES WERKZEUGMASCHINEN FABRIK, BERLIN.

The class and volume of work to be done necessarily fixes the capacity and number of cranes in use. If loam castings are to be made, then the power of the cranes has to be considerably increased over that which is necessary for green-sand or dry-sand castings. Per ton of castings made, loam moulds exceed in weight any others. When loam moulds are rammed in pits, as they usually are, they are lifted out after casting, the sand which has been used in ramming being only partially dug out. Such lifts add enormously to the crane power requisite, and so where loam castings are to be made a power of crane three times greater than the weight of the heaviest loam casting to be made is not too much.

PART OF SOUTH FOUNDRY, E. P. ALLIS WORKS OF ALLIS-CHALMERS COMPANY, SOUTH MILWAUKEE, WIS.

I trust that it unnecessary to say much regarding the use of cranes occupying the middle of the foundry floor. Whether they be hand, steam, or hydraulic cranes, their position on the moulding floor is objectionable, as they occupy the most valuable space for moulding purposes. Round these floor cranes there is also found, almost invariably, a heterogeneous and unsightly collection of all the rubbish and dirt a foundry can produce.

The circles A and B (next page) represent the area covered by the ordinary floor crane. As in few of these can the blocks be brought nearer the centre than 5 feet, in each crane an area of at least 78 square feet is absolutely lost for moulding. On the other hand, a heavy mould should have its centre not at the extreme distance the blocks will go towards the outer end of the jib. I have seen a not too-observant moulder forget that it is well to humour a crane by giving it vertical lifts to do. "Bedding in" a pattern a little out of the reach of the crane results in bad lifts, waste of time, and waster castings. When the moulds have to be cored all over, or have drawbacks on each side, then the furthest part of the mould must be easily within the radius of the crane. Only as auxiliaries to travelling cranes, and situated where they will give useful service with the occupation of least moulding space, are floor cranes admissible.

Next in importance to crane service is the question of situation of cupola, which depends of course upon the size of foundry to be served with metal.

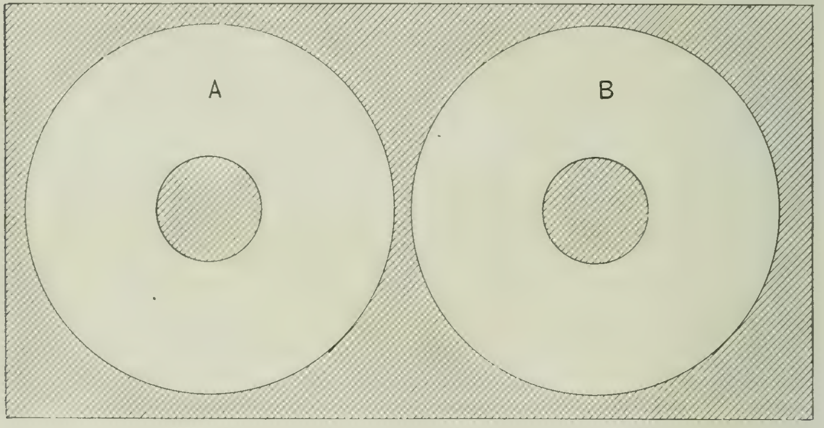


DIAGRAM ILLUSTRATING FAULTS OF CENTRE CRANES.
White area indicates portion served by cranes. Shaded portion is beyond their reach.

Foundries of sizes small to medium are best served if the foundry be an L in plan, having the cupola or cupolas in the inner angle. If the foundry be large and the work heavy to medium, then the best position for the cupolas is at the end of the main bays, the metal being conveyed along the bays by means of the travelling cranes.

A few foundries of very large area have the cupolas in the centre of the foundry, or as nearly equi-distant from all parts as it is possible to get. This is good if the work is all of a light character. The fluidity of metal required for thin or intricate castings is sure to be reflected in the cost of coke required for melting, if the distance over which the metal has to be carried is great. There are however obvious objections to centrally situated cupolas in foundries using crane ladles.

INTERIOR OF FOUNDRY, NILES TOOL WORKS, HAMILTON, OHIO.
View from front of cupola, which is situated at the head of the main bay.

ELECTRIC-CRANE ARRANGEMENT IN THE FOUNDRY OF THE YOUNGSTOWN STEEL CASTING COMPANY.
One four-motor 25-ton crane with 5-ton auxiliary hoist flanked by two 5-ton high-speed three-motor cranes. Designed to obviate delays of waiting for the cranes over a large foundry floor doing mixed light and heavy work. Northern Engineering Works, Detroit, Mich., U. S. A.

Wherever the cranes are, there must the cupolas be, and vice-versa. The cranes in such a case would be in the central bays, and as the largest castings would also be there, the transport of moulding materials and the castings themselves when made, place centrally situated cupolas at a disadvantage.

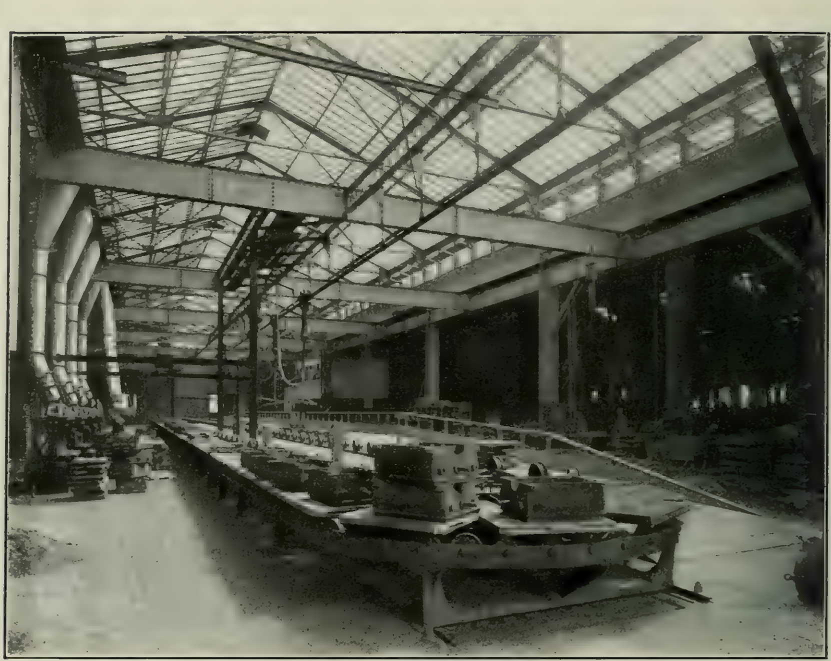
The cost of the distribution of melted metal is thus largely controlled by a suitable location of the cupola. Whether the metal be distributed by unskilled labour or by skilled labour, the cost of such distribution is inevitably reflected in the wages bill. Numbers of foundries have eliminated unskilled labour as far as it is possible to do so. It is quite possible to carry that too far and by doing so waste skilled labour in doing unskilled work. It is no more profitable to have skilled moulders wheeling sand or castings than it is to have a chief clerk copying letters. Each should be kept doing what he can do better than any one else, and the hewing of wood and drawing of water be left to those who can do that only.

The supply of minor plant and tools is an important item in foundry operations. Some foundry people commit the great mistake of

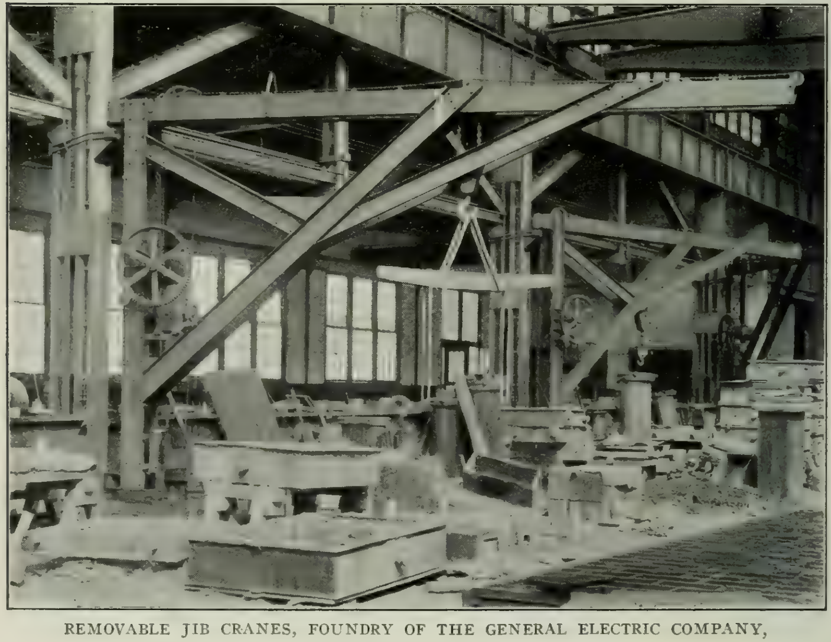
AN OVERHEAD CRANE IN A BAY OF THE E. P. ALLIS WORKS SOUTH FOUNDRY.

20-TON TRAVELLING CRANE IN TEMPORARY FOUNDRY, BALDWIN LOCOMOTIVE WORKS.
Wm. Sellers & Co.

trying to carry on work with the smallest possible equipment of riddles, sieves, buckets, brushes, shovels, and other tools whose name is almost legion. The only thing these economists do not grudge is the time and money wasted because of this shortage. I know of a large foundry where the economy was so thorough that one moulder used a 56-pound weight with a recessed bottom as a "swab-pot," and it was not at all uncommon to see a moulder brush off the joint of his mould with his cap; the brushes were in the store and stayed there. The men were paid so much per hour, so they did not mind; if they had been on piece-work rates there would have been trouble. The economy in minor plant and wastage of time had a result not difficult to guess. Money was lost (fortunately by those with some to spare) and the presiding genius had to seek an outlet for his economical tendencies in another than the foundry business. It may be taken as a safe rule that no workman ought to have to wait one moment for another to be done using sieve, riddle, brush, or whatever it may be. Each moulder should have a complete outfit of tools for his own particular use, these tools having his check number branded on each. Any bad usage of tools is by this means avoided, as responsibility for their condition is immediate, and in flagrant cases punishable. As a



SPECIALISED FOUNDRY ARRANGEMENT.
Moulding machines, travelling table, and air hoist, Westinghouse Air-Brake Works, Wilmerding, Pa.



REMOVABLE JIB CRANES, FOUNDRY OF THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

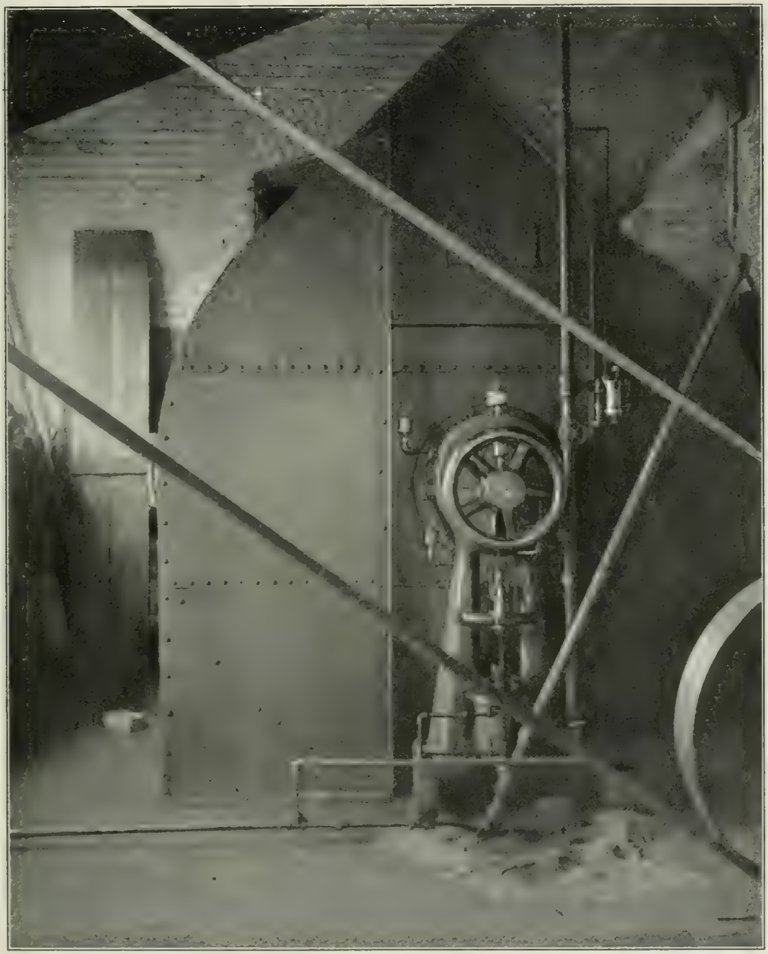
THE WEST ALLIS FOUNDRY OF THE ALLIS-CHALMERS COMPANY. 60-TON TRAVELLING CRANE IN PROCESS OF ERECTION.

matter of fact, such a condition hardly ever arises, as the moulder has every inducement to keep his tools in the best order. Where tools are few in number and so have to be used by all and sundry, they get thrown about from one to another, and as no one in particular is responsible for them they last only half the time they ought to do. Under such conditions more tools per man are used than if each had a set for his own use. It is obvious that if a certain number of tools be used in doing a day's work by one man, they will last only half the time if used by two men, even if no bad usage ensues from the dual ownership. Where larger numbers use the same tools the length of service decreases in proportion, so that instead of economy of tools there is a greatly increased wastage, and the time lost in addition is enormous. How is it that shortage of tools is seldom seen in piece-work foundries, but often in those where the hands are paid time rates? Piece workers would not put up with the delays due to such shortage, but evidently the employers who pay time rates and allow a shortage of tools are not aware of what a fearfully bad bargain they make. There are foundries now, I do not hesitate to say, where each man, by loss of time in waiting, will waste as much time every fourteen working days, as would pay for a complete outfit of the tools he requires. Give a moulder all the tools he can use, hold him responsible for their proper and legitimate use, and if so used, the sooner he uses them up the better for the employer.

A want of system or order in the foundry greatly conduces to wastage of tools, whether the supply be ample or no. Each man should have his outfit of tools, and also a place to put them when not in use, and it ought to be seen that he uses the facilities given. Where there is a shortage of tools, eight to ten men having the use of one riddle, one sieve, one brush, etc., an orderly system may actually cause waste of time, strange as that may seem. Here is an actual case. A number of men had been given, for their joint use, one set of tools. A place was appointed for each riddle, etc., this being a nail or spike in the wall on which the article was to be hung when not in use. The penalty of not replacing the riddle, etc., after use was instant dismissal. There was no need to dismiss anyone for this cause. The man who worked, say, 20 feet away, replaced the tool in position when done with, although his neighbour was going to use it in two minutes. As all were being paid time rates, if the management saw fit to cause them to waste time walking back and forward instead of employing them more profitably, while not liking it, there was no particular reason why they should not obey orders. Such a system was really more wasteful of money than if the tools had been thrown about from one to another as each was required for use.

I could also mention the hiding of tools, which takes place where a limited number are available, thus making the number still more limited, but enough has been said to show that an ample supply of minor tools is anything but a minor question when considering the elimination of all conditions which hinder production, and so add to the cost of the product.

When we come to consider the atmospheric conditions which prevail in most foundries we find a state of matters which would not be tolerated by either employer or employed in any other department. In the foundry it may be, and I admit is, difficult to have the air pure and free from draughts, and the difficulty is usually avoided by simply considering it and passing to some easier and more hopeful question.



VENTILATING FAN, FOUNDRY OF THE SANDY HILL IRON AND BRASS WORKS.

In winter the blower room can be closed against the outside air, drawing warmed air from within the works. Buffalo Forge Company's system.

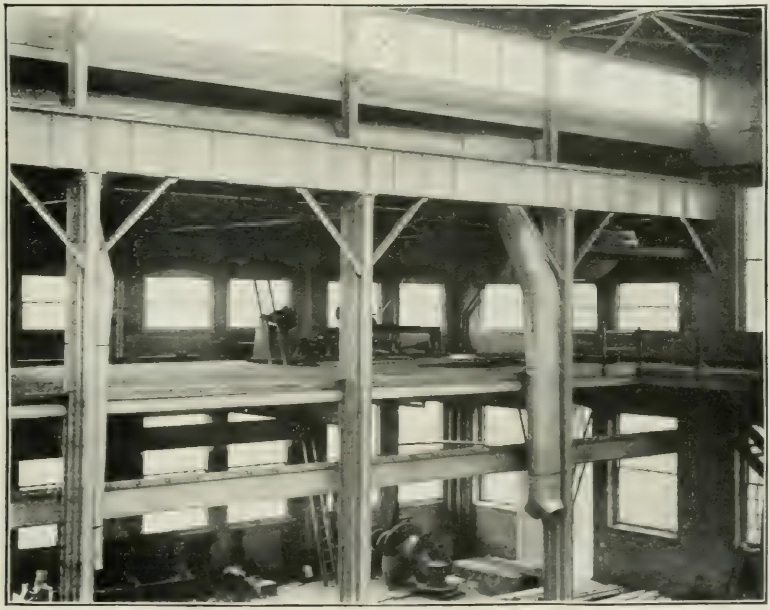
It is unnecessary, I hope, to say anything regarding the influence of the surroundings or environment upon the physical and moral health of the worker, be he managing director, or the last boy recruit brushing sand off castings in the dressing shop. The purer the air, the better the light, the more general comfort which prevails, the better will the results be in a material sense. It is no exaggeration to say that an examination of the cases of sickness amongst foundry workers will show that respiratory troubles form nine-tenths of the whole. These in great part arise from the conditions under which foundrymen work, and if not altogether to be avoided, can certainly be greatly improved.

HEATING AND VENTILATING ARRANGEMENT IN FOUNDRY OF SANDY HILL IRON AND BRASS WORKS, SANDY HILL, N. Y.

The air from the blowers shown on the preceding page is thrown into the foundry through the pipes shown in the left foreground, the opening in the cupola-house wall, and other vents on the farther side of the charging floor.

What I would suggest here is the general use of fans at suitable openings in the foundry walls or gables, for the purpose of expelling the impure air and noxious gases, whether arising from pits, drying of ladles, or casting of moulds. Whether the fans be driven by a belt or by an electric motor, they should be such as may be put on or off at will. In the case of foundries having a constantly smoky atmosphere they would run almost constantly, but in the greater number of foundries, with such a condition only intermittent, then the fan would be used only as required.

That foundries require warming will be a surprise to many. It is true, nevertheless, that more time is lost in the course of a year through cold than through heat. In the United States, such is the extent of country, there are all sorts of climates and so the heating of foundries in winter is not universal because not necessary. In the northern states, and of course in Canada as well, heating the foundry in winter is an absolute necessity. In Great Britain the systematic heating of the foundry has been left severely alone, and in its place are to be seen a various assortment of fires upon the floor, combining quite successfully a maximum of smoke with a minimum of heat. It is a curious phenomenon that in winter it takes three times longer to get a core from the core stove than it does at any other season of the year!



THE NEW FOUNDRY OF THE CANADA FOUNDRY COMPANY (CANADIAN GENERAL ELECTRIC COMPANY), TORONTO.

Showing Sturtevant system of heating and ventilation applied to both the main foundry floor and the gallery. The air pipes are seen following the alternate pillars.

If the fuel which is burned in the fires mentioned were used in a system of heating by hot-water piping, or by hot air delivered into the foundry, the improved conditions would reflect themselves in increased output. There would be a much more equable temperature, attention to the numerous fires mentioned would be wholly obviated, and there would be less hanging around the core and other stoves, especially in the mornings. That much time is lost in the cold weather may be largely ascribed to the want of a proper system of heating.

FOUNDRY VENTILATION. STURTEVANT SYSTEM AT THE SACO AND PETTEE COMPANY'S FOUNDRY, NEWTON UPPER FALLS, MASS.

Warm fresh air enters through the pipes seen in the middle background, being forced in by blowers placed behind the wall.

Draughts in the foundry play a more important part than would be credited by one who has not experience of their effects. In winter the effects are principally upon the men, though I have seen a mould frozen by the cold air blowing through an open door. In summer the effect is upon the mould, drying it up and so prolonging the finishing.

The doors are in almost constant use, and in very many cases the large doors have to be opened wide on every occasion, as the designers of the foundry in the first place, and the carpenters in the second place, omit to put a small door by which individual workers may go out and in through the large door; the result is that the latter, being heavy and cumbersome, is left open all the time.

I have considered, as shortly as the importance of the subject will allow, some of the general conditions which should obtain in a foundry. Any one of these may be considered as of no great moment were it neglected, as, unfortunately, it too often is. We cannot afford to neglect the combined influence of the whole. Every stroke of the rammer, every grain of moulding sand used, has an influence upon the casting produced. So there should be made to converge upon production all the influence of suitable conditions, and by the elimination of all neutralising forces, good and economical working is assured.

# COST-FINDING METHODS FOR MODERATE-SIZED SHOPS.

## I.—THE SYSTEM OF THE BIGELOW COMPANY, OF NEW HAVEN.

*By H. L. Arnold.*

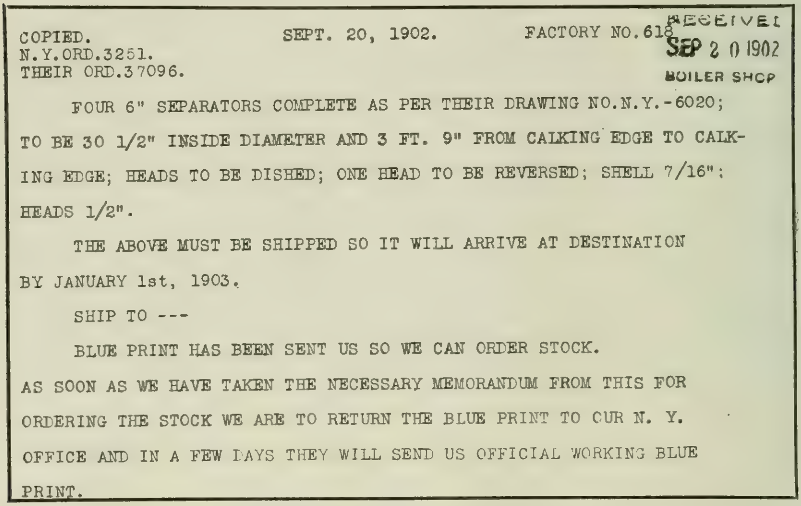
Mr. Arnold's article is the first of a group devoted to practical cost-keeping systems suited to a small shop or to a separate department of a large shop. Each of the papers will describe a method in actual daily use—one which has been studied out in the works, tested under practical conditions, and proved successful. Forms, blanks, etc., will be reproduced in full, and their use clearly explained. The shops have been selected to cover a wide range of mechanical work, and the writing of each paper has been committed to a competent expert in cost-keeping, to secure the utmost interest and value in the way of clear, discriminating, and critical exposition.—THE EDITORS.

THE cost-keeping methods of the Bigelow Company, manufacturers of boilers at New Haven, are taken as illustrative of a successful system for an establishment working about two hundred men, partly on inside work and partly outside. The system itself is the outcome of systematic and deliberate study—a construction rather than a growth.

The company is organized under a president, a general manager, who is present most of the time at the works, and a vice-president and sales manager in the New York office.

The works are divided into two general departments, the one known as the machine, pattern, and blacksmith shop, and the other as the boiler and sheet-iron shop; these are in charge of separate foremen. There are two separate tool rooms, one for the machine shop and one for the boiler shop, which are in charge of separate tool-room foremen.

The rough stores consist mainly of castings, rivets, plates, and stamped or formed plate details, as man-hole covers, pressed steel being now used in places where castings were formerly employed. The castings, which are mostly large, are all purchased outside, and are stored in the open yard adjacent to the departments where they are to be worked. The rivets go to the stores room opposite the office, and are in charge of a youth, who delivers them on verbal orders from the rivetting-gang bosses. He turns his memoranda over to the stock clerk, who is in charge of the rivet room and sheet stores, and delivers sheets to the layer-out, under directions from the boiler-shop superintendent. The superintendent's requisitions are based on the separate order specification received from customers, which are transmitted directly to the works and form the production orders. These orders are so varied that no production-order blank is used. Each order thus takes the form of a type-written specification, in general form similar to the one below.



COPIED.
N.Y.ORD.3251.
THEIR ORD.37096.

SEPT. 20, 1902.

FACTORY NO.618

RECEIVED
SEP 20 1902
BOILER SHOP

FOUR 6" SEPARATORS COMPLETE AS PER THEIR DRAWING NO.N.Y.-6020; TO BE 30 1/2" INSIDE DIAMETER AND 3 FT. 9" FROM CALKING EDGE TO CALKING EDGE; HEADS TO BE DISHED; ONE HEAD TO BE REVERSED; SHELL 7/16"; HEADS 1/2".

THE ABOVE MUST BE SHIPPED SO IT WILL ARRIVE AT DESTINATION BY JANUARY 1st, 1903.

SHIP TO ---

BLUE PRINT HAS BEEN SENT US SO WE CAN ORDER STOCK. AS SOON AS WE HAVE TAKEN THE NECESSARY MEMORANDUM FROM THIS FOR ORDERING THE STOCK WE ARE TO RETURN THE BLUE PRINT TO OUR N. Y. OFFICE AND IN A FEW DAYS THEY WILL SEND US OFFICIAL WORKING BLUE PRINT.

THE TYPE-WRITTEN PRODUCTION ORDER.

Every needful statement of requirement and condition, date of order and delivery date included, is, as will be observed, noted on this production order, so that the work can be intelligently brought out in the shops. Some of these individual-specification production orders are much longer than the one given; others are much shorter, calling perhaps for a number of rivets of a certain kind, or a piece of boiler plate punched and bent to certain specifications. All of these production orders are simply type-written sheets or slips, made either at the New York or New Haven offices of the works according to place of receiving them, and go directly to the department superintendents, without formalities or loss of time. If received in New York, the order bears a New York office order number, and each order is given a factory number, against which all production charges are entered. All orders are first copied in numerical sequence in the general factory-order copying-press book, kept in the main factory office, and two duplicate order copies are made, one being delivered to the cost clerk, who has an office with the boiler-shop superintendent on the ground floor adjoining the main boiler shop. He pastes all his copies in a large book marked "Boiler-Shop Orders." The second duplicate goes to the superintendent of the machine shop, who has a similar book, lettered "Machine-Shop Orders," in which he pastes his full copy of each production order complete. The machine-shop superintendent and the boiler-shop superintendent and the cost keeper thus each have all particulars of each order, and each proceeds independently to bring out his individual portion of the structure demanded; in most cases the machine-shop work must and does, of course, precede the boiler-shop work.

All requisitions made by the machine-shop and boiler-shop superintendents on the rough-stores clerk have the order number, and the stores are delivered by the stores clerk and by him charged on his "Stores Delivered" book against the order numbers.

If a rough-stores order cannot be filled from stores in stock, the rough-stores clerk makes a proper order which goes through the main office to the outside source of supply. The rough-stores clerk examines the boiler-shop and machine-shop order books twice daily, morning and afternoon, and scrutinizes each order with care, and makes his requisitions on outside sources at once, so that the least possible delay intervenes between the receipt of a production order and the placing of needed material in the rough-stores room.

The tool-room charges are made against individual workmen on Form 1, reproduced in full. These forms are kept in alphabetically designated pigeon holes in racks in the two tool rooms, the same form serving for both. Charges are made by the tool-room keepers against the workman whose name heads the form, when tools are taken out, and cancelled by crossing off the charge when tools are returned in good order. Tools returned in bad condition are made the subject of inquiry if occasion demands, and may be charged to the workman if he is grossly in fault.

Flat-cost charges are made against production-order numbers on the boiler-shop and machine-shop detail-charges sheet, Form 2, enough sheets being numbered with each order number to contain all the charges against it. Form 2 is printed on both sides, and the back is in two forms, one for boilers, and one for machine and miscellaneous orders. These forms are filled by the cost clerk from the rough-stores book for the entries on the back, and finally, after both back and front sides are filled, they go to the bookkeeper, who enters the totals on the margins of the office order-book sheets where the original production orders are pasted. These blanks are then stamped "Charged" in large capitals, green ink, and are finally filed for future reference.

**Name,** .................................................. **Date,** ..................................

No. of Pcs.

### DRILLS AND SOCKETS.

---- Drill Sockets, Size ------------------ Kind ------------------
---- " Chucks, " ------------------ " ------------------
---- Twist Drills, Size, ----- Taper, ------- Straight, ------- Groove, ------
---- Ratchet " " ------- " ------- Square ------- " ------
---- Flat " " ------- " ------- " ------- " ------
---- Counterbores " ------- " ------- " ------- " ------

### TAPS.

---- Hand Taps, ------ Size, ------ Taper, ------ Straight, ----- Bottoming, -----
---- Stay Bolt Taps, " ------------------------------------------
---- Pipe Taps, " ------------------------------------------
---- Special Taps, " ------------------------------------------

### PUNCHES AND DIES.

---- Screw Punches, Size, ----------- Dies, ----------- Punches -----------
---- Tube " " ----------- " ----------- -----------
---- Rivet " " ----------- " ----------- -----------

### TUBE EXPANDERS AND TOOLS.

---- Expanders, ----------- Size, ----------- Pins, ----------- Rolls, ----------
---- Tube Cutters, " ------------------------------------------
---- " Reamers, " ----------- Cutters, --------------------

### REAMERS.

---- Pipe Reamers, Size, ------------------------------------------
---- Rivet " " ------------------------------------------

### WRENCHES.

---- Monkey Wrenches, Size, ------------------------------------------
---- Open " " ------------------------------------------
---- Ratchet " " ------------------------------------------
---- Adjustable " " ------------------------------------------
---- Tap " " ------------------------------------------
---- Hack Saw Blades, ------------------------------------------

### HAND TOOLS.

---- Snap Rivet Cupping Tools, Size, ------------------------------------------
---- Handle " " " ------------------------------------------
---- Hand Markers, " ------------------------------------------
---- Chisels, Cape ----------- Diamond Point, ----------- Flat, ----------
---- Chipping Hammers, ------------------------------------------
---- Riveting " ------------------------------------------
---- Drift Pins, ------------------------------------------

### PNEUMATIC TOOLS.

---- Engines, --------------- Piston, --------------- Rotary, ---------------
---- Hose, ------------------------- Length, ------------------------
---- Hammer, --------------- Calking Tools, ------------------------
---- " --------------- Beading Tools, ------------------------
---- " --------------- Stay Bolt Cups, ------------------------
---- Hydraulic Jacks, Size, ------------------------------------------
---- Chain Falls, " ------------------------------------------

FORM I. TOOL-ROOM CHARGE SHEET.

The original is more open, being 5 by 14 inches, heavy manila paper.

## BOILER SHOP—FACTORY NO.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DRILLING | | | | RIVETING | | | | | | |
| LAYING OUT | PUNCHING | PLANING | ROLLING | HEADS | SHELL | NOZ & FIG | FITTING UP | MACHINES | FLOOR | BRACES | TUBES | CALKING | TESTING | HANDLING STOCK | LOADING & PAINTING |
| | | | | FLANGING | | | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PATTERN SHOP | | | | | | MACHINE SHOP | | | | | SMITH SHOP | | | |
| FRONT | BRACKETS NOZZLES | LOADING | HEADS | FRONT | NOZZLES FLANGES | PIPING | FEED | TAPPING | LOADING | BRACES | HANGERS | FRONT | ANCHORS ROLLS | |
| | | | | | | | | | | | | | | |

FORM 2. FRONT. FILLED BY COST CLERK FROM WORKMEN'S TIME SHEETS.

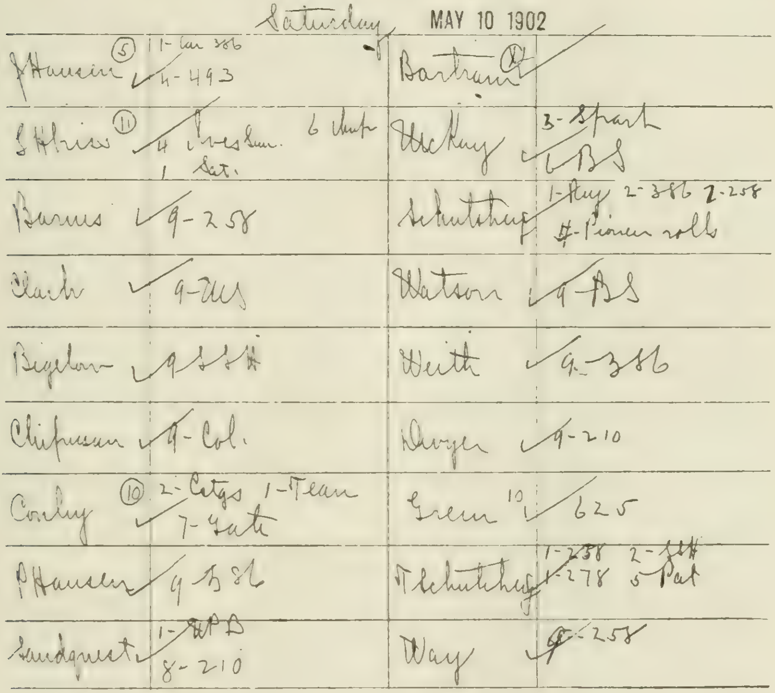
It will be noted that the various classes of work have different entry spaces. The form is printed in black on a stiff white card 9¾ by 5½ inches. The original has a few blank extra columns in each shop space, for special entries.

| | | | | | |
|---|---|---|---|---|---|
| | Plates in shell | | | | |
| | Straps | | | | |
| | Dome plates | | | | |
| | Dome heads | | | | |
| | Heads | | | | |
| | Barrel plates | | | | |
| | Fire box plates, Inside | | | | |
| | Fire box plates, outside | | | | |
| | Top head | | | | |
| | Fire box head | | | | |
| | Reverse flange | | | | |
| | Rivets | | | | |
| | Stay bolts, solid | | | | |
| | Stay bolts, hollow | | | | |
| | Feet of ______ tubing | | | | |
| | Feet of ______ tubing, extra heavy | | | | |
| | Brackets, cast iron | | | | |
| | Nozzles " " | | | | |
| | Flanges " " | | | | |
| | Fronts " " | | | | |
| | Castings for setting | | | | |
| | Braces, bar iron | | | | |
| | Anchor bolts " " | | | | |
| | Hangers " " | | | | |
| | Front " " | | | | |
| | Front, angle iron | | | | |
| | Trimming | | | | |
| | Stiffeners | | | | |
| | Fusible plug | | | | |
| | Manhole plates | | | | |
| | Handhole " | | | | |
| | Sheet iron | | | | |
| | Angle " | | | | |
| | Feed pipe | | | | |
| | Bolts | | | | |
| | Fire brick | | | | |
| | Insurance | | | | |
| | Hours Boiler Shop | | | | |
| | " Machine Shop | | | | |
| | " Forging | | | | |
| | " Pattern Shop | | | | |
| | " Draughting | | | | |
| | Lumber etc. for loading | | | | |
| | Cartage | | | | |
| | Freight | | | | |

FORM 2. BACK OF WORKMEN'S TIME SHEET.

This is known as the "Regular" back, as it contains spaces for all regular charges against horizontal or Manning vertical boilers. The "Special" form has no printed list, but is filled by entering the order. Weights or numbers are entered in the first vertical column, flat cost values in the second. Particular conditions or charges are noted in the horizontal lines at the top. The form, as noted under the copy of the front on page 389, is 5½ by 9¾ inches.

The workmen's time cards are in manuscript, written by the cost clerk, and by him filled from information gained by questioning individual workmen in the machine shop, from each individual smith's book kept by himself in the blacksmith shop, from the pattern-shop time book, which is made up by the cost keeper by individual questioning, and from the boiler-shop gang bosses, who keep slates or chalk-mark records of the one day. Every piece of stock takes the job number in white paint when delivered from the rough-stores room.



Saturday MAY 10 1902

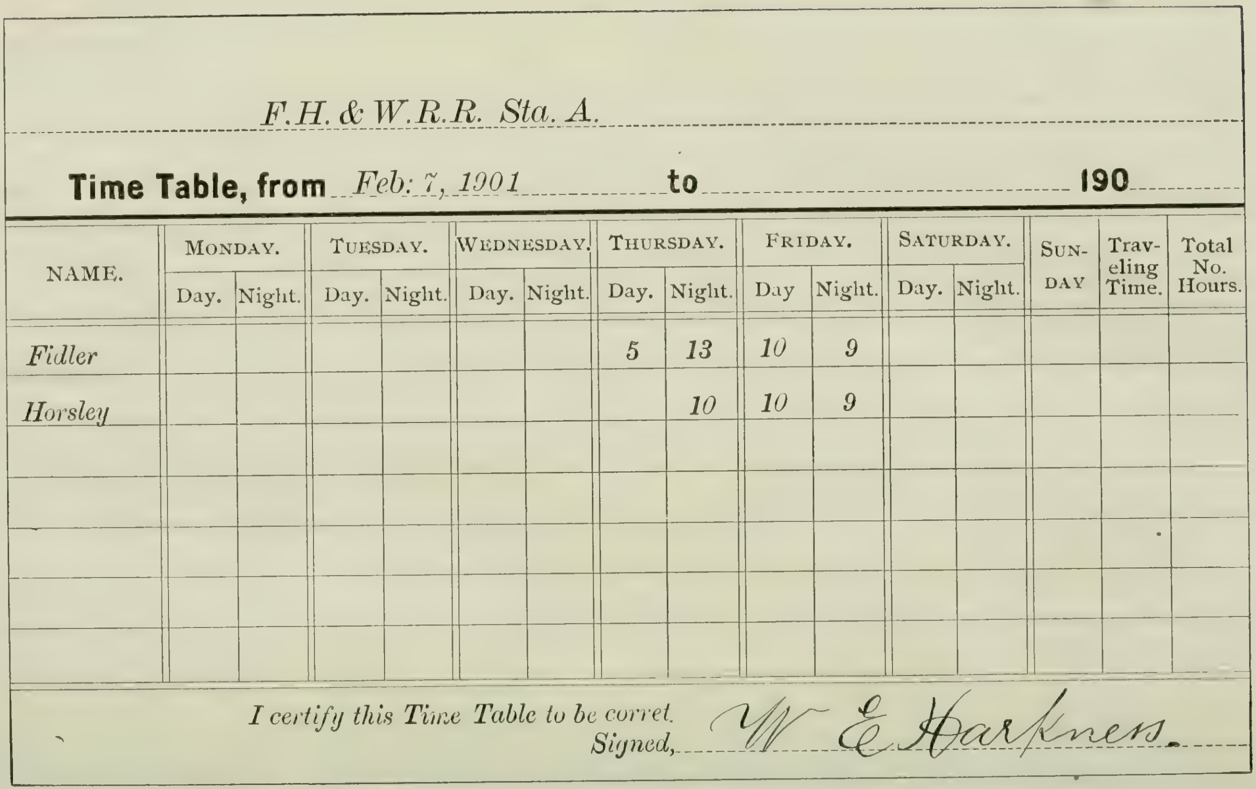
| | | | |
|---|---|---|---|
| J Hansen ⑤ | 11-Car 386<br>✓4-493 | Bartram [illegible] | ✓ |
| S Harris ⑪ | ✓4 [illegible] 6 [illegible]<br>1 Sat. | McKay | 3-Spark<br>✓6-BS |
| Barnes | ✓9-258 | Schutting | 1-Key 2-386 2-258<br>4-Pinion rolls |
| Clark | ✓9-Ms | Watson | ✓9-BS |
| Bigelow | ✓9 [illegible] | Weith | ✓9-386 |
| Chipman | ✓9-Col. | Dwyer | ✓9-210 |
| Conley ⑩ | 2-Cstgs 1-Team<br>✓7-Gate | Green 10 | ✓625 |
| P Hansen | ✓9 [illegible] | T Schutting | 1-258 2-[illegible]<br>✓1-278 5 Pat |
| Sandquist | 1-WPB<br>✓8-210 | Way | ✓9-258 |

MACHINE-SHOP DAILY-TIME CARD.

A partial exhibit. The date is stamped in green ink, and the manuscript written daily by the cost clerk. Short-time and over-time entries are enclosed in circles. The boiler-shop time sheet is kept in the same way.

The smith-shop workmen's time is taken in the same way, the boiler-shop workmen's names lists and the smiths' names lists being written together daily, on large sheets, of sufficient size to contain all.

Outside work is recorded on two similar blanks, Form 3, 4⅜ inches by 6½ inches, grey and terra-cotta color, stiff cards. Both these cards are filled by the outside worker day by day, as he works, with both time and material charges, and both are signed by the fore-



*F. H. & W. R. R. Sta. A.*

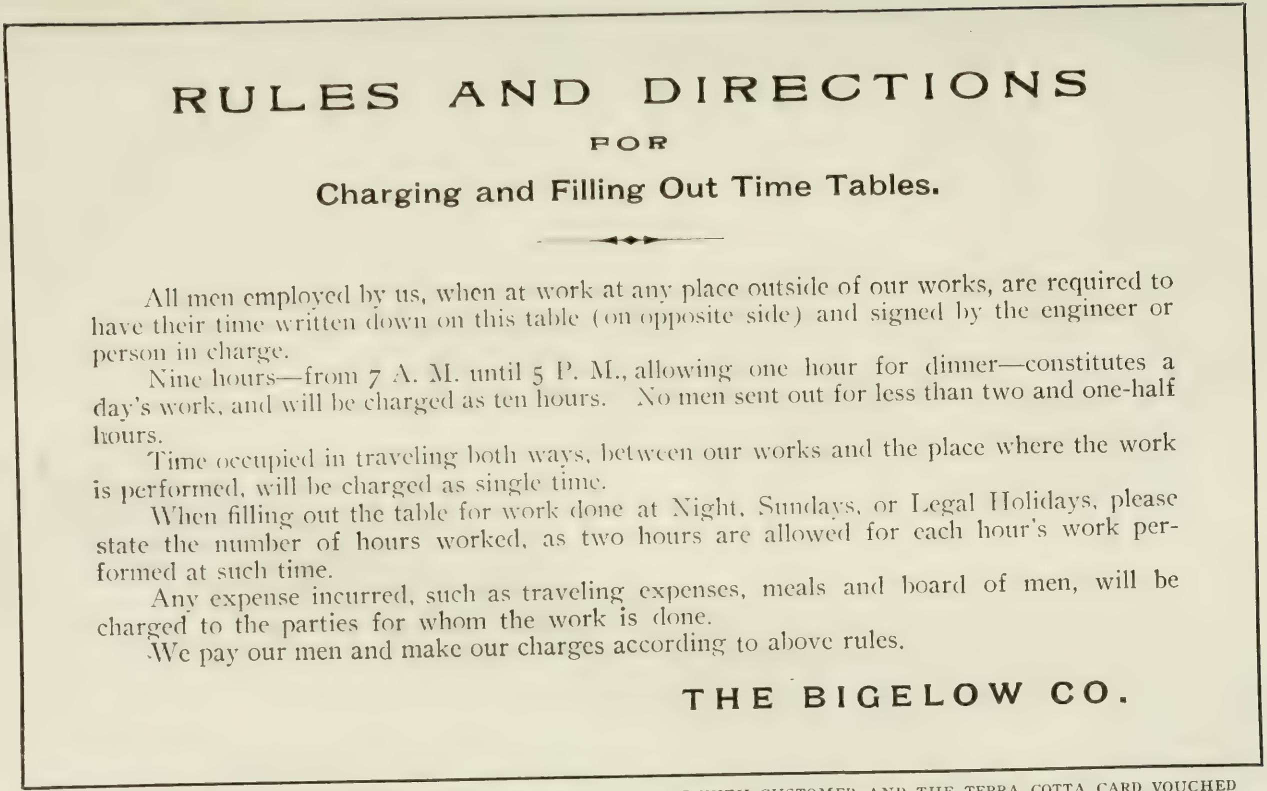
**Time Table, from** *Feb: 7, 1901* **to** **190**

| NAME. | MONDAY. | | TUESDAY. | | WEDNESDAY. | | THURSDAY. | | FRIDAY. | | SATURDAY. | | SUNDAY | Traveling Time. | Total No. Hours. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day. | Night. | Day. | Night. | Day. | Night. | Day. | Night. | Day | Night. | Day. | Night. | | | |
| *Fidler* | | | | | | | *5* | *13* | *10* | *9* | | | | | |
| *Horsley* | | | | | | | | *10* | *10* | *9* | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

*I certify this Time Table to be corret.*
*Signed,* W E Harkness.

FORM 3. OUTSIDE-WORK CARD, FRONT; AS FILLED AND VOUCHED BY CUSTOMER.

A stiff card, terra-cotta color, 6½ by 4½ inches. The back of the form is shown on page 393. A duplicate of this card, gray in color, and headed "Duplicate. Keep this Card to Compare with Bill," is left with the customer.



# RULES AND DIRECTIONS

## FOR

## Charging and Filling Out Time Tables.

All men employed by us, when at work at any place outside of our works, are required to have their time written down on this table (on opposite side) and signed by the engineer or person in charge.

Nine hours—from 7 A. M. until 5 P. M., allowing one hour for dinner—constitutes a day's work, and will be charged as ten hours. No men sent out for less than two and one-half hours.

Time occupied in traveling both ways, between our works and the place where the work is performed, will be charged as single time.

When filling out the table for work done at Night, Sundays, or Legal Holidays, please state the number of hours worked, as two hours are allowed for each hour's work performed at such time.

Any expense incurred, such as traveling expenses, meals and board of men, will be charged to the parties for whom the work is done.

We pay our men and make our charges according to above rules.

**THE BIGELOW CO.**

BACK OF FORM 3—OUTSIDE-WORK CARD—BOTH THE GRAY CARD LEFT WITH CUSTOMER AND THE TERRA COTTA CARD VOUCHED BY CUSTOMER AND RETURNED TO THE BOOKKEEPER.

man or customer where the outside work is done. When the job is finished the grey card and the terra-cotta cards are thus duplicates, vouched by the outside authority signature. The terra-cotta card goes to the cost clerk and the bookkeeper, and the bookkeeper makes a bill therefrom to the customer. The grey card is left by the workman, on completion of the job, with the customer. As this card bears the customer's own voucher it cannot be disputed.

When the customer receives the bill he has only to compare the total charge of time and material with the duplicate in his possession. These outside-work blanks are printed on both sides. The back is printed with the workman's instructions, and the front is printed and filled as shown in the two reproductions given showing the customer's duplicate and the factory time card.

The items of "unproductive labor," which include every sort of work done, other than office and clerical work, not directly charged to any production order, are taken by the cost clerk daily, in his round through the shops, made when he fills his daily manuscript time sheet. The separate items are recorded in detail on a monthly-statement sheet of unproductive labor, which is turned in to the bookkeeper and by him is charged to expenses, divided into various charges against shop betterment, patterns, shop cleaning, and so on.

The shipping clerk besides attending to shipment details does some estimating; he looks out for the railway transportation, and is responsible for shipping details generally. Work ready for shipment is notified to him by department foremen on a "Ready for Shipment" card, white, 3 by 4 inches, stating that "Order No. —— is now ready for shipment," and signed by the foreman. The clerical force comprises a chief bookkeeper, shipping clerk, rough-stores keeper, with an assistant youth in charge of rivets, the cost keeper, and his assistant, also the stock clerk. The number of men in work varies from 175 to 200, as orders demand.

Almost the entire work of collecting and recording prime-cost items is performed by the cost keeper; his assistant, the stock clerk, has the receipt and delivery of stores in charge. The cost keeper is also the time taker, and rules and fills the manuscript time cards every day, and also handles the brass check board and workmen's brass individual checks, by which the entering and leaving times of the workmen are recorded, and does this work so easily as to have spared five hours in one day for giving the information here presented to the writer, without apparent inconvenience.

Each rivet order is filled in small excess of number, and from time

| RACK | NO. OF PLATES | LENGTH | WIDTH | THICKNESS | FACTORY<br>ORDER NO. |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

FORM 4. SHEET SHOWING DELIVERY TO WORKS ON PRODUCTION ORDERS.

The original is a stiff white card, 5 inches wide and 7 inches high, having 16 entry lines under the heading as shown. The plates are stored in racks, and the first column shows sheet-rack numbers.

to time the left-over rivets are collected in bulk and delivered to the youth in charge of the rivet bins, who sorts them into their individual places. The rivet shed stores the flanged work, one side being occupied by rivet bins and kegs, and the other side by flanged work, and pressed-steel man-hole plates.

In addition to the forms shown, there are two books of copied entries made up from the cost keeper's time sheets, one named "Machine-Shop Day Book," and the other "Boiler-Shop Day Book." These books are both written by the cost keeper daily, and these two day books are written by the bookkeeper into finished-product bills, made to purchasers. These day-book items are variously stamped in green ink by the cost keeper, "Outside Work, No Material," "Outside Work, Material Charged," as may be, in one right-hand column and the last entry on a given order is followed with a "Completed" stamp in green ink.

While this costing system shows a firm resistance to the multiplication of form blanks, and some comparatively unimportant items are not rigorously collected, it is nevertheless true that close approximations to accurate costs are made by its use, and it is also true that these fairly correct costs are obtained by a very small outlay of clerical labor, and the long-continued prosperity of the company amply proves the practical sufficiency of this simple set of cost-keeping forms.

The fact that the boiler-shop gangs are made up of constantly changing permutations of the same workmen, gives rise to the manuscript time sheets in the form of original productions by the hand of the cost clerk for each day's record.

# THE ECONOMICAL SIGNIFICANCE OF A HIGH WAGE RATE.

### *By Percy Longmuir.*

**In an article in our preceding issue, Mr. Longmuir demonstrated, by an analysis of wages and work in the Midlands and North of England, the fallacy of the idea that low wages for unskilled work were of necessity economical. A fair or even high living wage kept the workman so much more efficient that he far more than repaid his employer's extra outlay. In the following paper Mr. Longmuir applies a similar argument to the case of the skilled worker. Both phases of the discussion are strongly pertinent to the issue in the United States anthracite field.—The Editors.**

IN a preceding article the economy of a high rate was considered in the case of unskilled labour only. With this class of labour the economy is evidenced in the maintenance of a higher standard of physical efficiency, and to obtain this increased efficiency it pays to raise the rate to a sum upon which the worker can with some show of reason store in the requisite energy in the form of food. But even high rates in the case of unskilled labour are of necessity too low to be regarded in any other light than that of maintaining bodily efficiency only. However, as bodily efficiency and mental capacity are associated, the creation of a class of general labourers so equipped forms a good reserve upon which to draw for handy men and semi-skilled workers. An avenue is thus opened by which the general labourer commences to ascend the industrial ladder and to attain rates which offer more advantages in the way of living. A method of selection is opened to the employer, which, judiciously handled, acts as a powerful stimulant in developing a spirit of enterprise in bodies of men who otherwise are in a state of apathy.

With skilled workers the rate is, generally speaking, decidedly above Rowntree's poverty line* and in considering the economical significance of high or low rates other factors than the one adopted in the case of unskilled workers must be considered.

In the first place, the word economy is one which permits of wide application; but narrowing down the general sense of the word it may be taken as the careful and judicious use of anything, such as time, material, labour, money, etc. Thus thrift and economy are in some respects synonymous terms, thrift being generally taken as economical management. In any form of works management thrift is essential to success, but the measure of that success is dependent on the particular form of thrift adopted. For instance, there are many familiar examples of thrifty men who, in spite of their very evident economy, make little or no headway and who possess none of that healthy vitality so necessary to real advance. It follows that in undue straining after economy the vision is warped and the outlook narrowed —hence the loss of vitality. Economy to be genuine must be rational and broad; it must look not at the immediate present but make provision for any possible contingency likely to arise. The latest development of this spirit of far-sighted economy is to be found in the use made of the scrap heap by progressive establishments. To this heap are relegated methods and tools the moment they can be replaced by better ones, and it is recognised that it is with the best, and only the best, tools or methods that full success will be achieved. It is apparent that methods of management have as important an effect on the character of the work produced as have the tools and appliances.

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* The minimum upon which it is possible to maintain mere physical efficiency. For a family of five, under average conditions found in Great Britain, Rowntree's "poverty line" is an income of 21s. 8d. ($5.20) a week.

Sympathetic methods of management have been scoffed at as bribes to the worker to be a sort of "good child." High rates are in many cases regarded in the same light, epecially by those who pay low ones. It is surely unnecessary to state that such views are short-sighted, for sympathetic methods are based on a very full grasp of human nature which recognises that better treatment on the part of the management yields correspondingly better results from the worker. Therefore high rates are an incentive to greater effort on the worker's part, and up to a certain point this effort will increase with the rate, in that an ascending rate produces a higher calibre of workers. Successful economical management lays stress on the necessity of obtaining the greatest possible output per unit of production. This highest possible must be obtained alike from each individual man and each separate machine, and when obtained can be taken as representing the judicious and far-sighted economy defined in the preceding paragraph. As far as the machines are concerned, before such a state of efficiency is obtained much outlay of thought and capital will be required. This is generally recognised, and tools are the subject of thought and experiment before purchase. But how much thought or experiment is devoted to the question of human tools? In the majority of cases practically none. Full economy is a matter of the best tools, the best workers, and the best methods, none of which can be secured without an outlay of thought and capital; and in practice it is found that the greater the expenditure of these joint factors the greater is the return.

As the economy obtained from good tools is necessarily co-existent with and dependent upon that obtained from good workers, it follows that the latter must receive as much thought as the former. An equivalent outlay of the joint factors in both cases is essential to full economy. A tool bought without thought at a high figure will not necessarily prove economical; neither will an indiscriminate increase of wages result in a greater output from the workers. However, the tendency to err in this respect is not great, and where high rates are adopted they are in all cases understood as the reward of efficiency. As with the unskilled workers, so with the skilled one—high rates result in a better personnel, and it is found that the better quality men gravitate to those districts in which wages are highest.

For convenience, skilled-labour rates may be taken as ranging from 30 to 46 shillings per week of 54 hours; these limits also determine for the purpose of this paper the "low" and "high" rates. Some of the contrasts between low and high rates may be tabulated as follows:

| | | |
|---|---|---|
| Low rated areas in which the rate varies from 30 s. to 35 s. | Low state of efficiency. | 1. Low output.<br>2. High percentage of spoiled work.<br>3. Poor use of time, material, and tools.<br>4. Short-sighted narrow outlook—consequently hard to manage.<br>5. Self esteem and ambition low. |
| High rated areas in which the rates vary from 36 s. to 46 s. | Greater efficiency. | 1. High output.<br>2. Low percentage of spoiled work.<br>3. Time, material, and tools used to better advantage.<br>4. Better balance of mind and wider outlook — consequently easier to manage.<br>5. Self esteem, intelligence, and ambition higher. |

The reduction in percentage of spoiled work with the higher rates is no small item in favour of their economy; this is also associated with a fuller use of time and tools, the latter being made to yield more and at the same time receive better treatment. The economy of material is due in the first place to the lessening of wasters, and in the second to intelligent use. This intelligence is also responsible for the increased output; a thinking worker will make every movement and every stroke tell and will give just the necessary number, neither more nor less. An unthinking one may put in far more strokes than are necessary, every one of which may also vary in effectiveness. The manner in which different grades of carpenters drive home a nail is very instructive in this respect, and also illustrates the fact that though a certain number of blows are necessary, one too many will damage if not spoil the work. Hence the higher quality found with the increased output of the higher rate is due to the fact that the worker aided by his thoughts gives just the requisite number of effective strokes and no more. The quality of the product is high because the worker's thoughts have been concentrated on his task. The question then naturally arises, why can not this concentration of thought be obtained in the low-rated areas when strict methods of management are adopted? It is true that increasing the strictness does give rise to more thought on the part of the worker, which is devoted not to the work in hand but to devices for hoodwinking the management, and usually the worker is successful. Continued hustling can succeed in producing a mere show of work only; real concentration on the worker's part will never be obtained in such a manner. Judicious management recognises that it is true economy to purchase a tool costing £75 which will produce twice the amount of work yielded by one costing £50. So with the human element; if one man at 40 shillings will produce twice the amount of work to be obtained from one at 30 shillings, then on the face of it the former is the more economical man. Just as no amount of pressure would make the £50 tool equal the £75 one, so no amount of hustling will make the 30-shilling man equal the 40-shilling one.

High rates are necessarily based on the principle of payment by result, which is translatable into the reward of efficiency. It has been already stated that full economy can result only from the highest efficiency; inefficiency even on the lowest rung of the skilled-labour ladder must eventually prove costly. In aiming for this efficiency the rate of payment should be considered only in the relationship it bears to the ultimate cost of the product. Too often this relationship is ignored and the rate regarded as an entity itself.

High rates have a very marked effect on the workers themselves. In the first place, the increased payment has an educational effect in that it broadens the outlook by widening the worker's horizon. Thus a certain amount of travel becomes possible and holidays can be spent away from home—an educational factor of no small import, for nothing better can be found to rub off the corners than contact with unaccustomed conditions. The increased income gives an assurance which increases self-respect and fires the ambitions, giving a desire to know more and achieve more; thus an interest is aroused in some form of technical or general literature. Increased home comforts are possible—and the taste they awaken, once acquired, the owner usually strives to gratify further. Congenial surroundings give a balance of mind which will effectually minimise industrial troubles.

Quite apart from a lessened cost of production, high rates are economical in that they tend to produce alert and shrewd workers, men who can "see" as well as "do." The better influences at work on the character, due to the possibilities opened out by the higher rate, tend to develope inventive faculties and the power of concentration—two items of great import to the employer.

It will be argued, and with some show of truth, that an increase in pay will benefit not the worker and his family but the publican and the bookmaker. Much colour is lent to this view by the fact that in very many cases nearly the whole of the income is deposited over the bar counter. But a deeper examination will show that in such a case, the workers so doing could not continue long on high rates, the maintenance of which depends on a low cost of production. High rates place a premium on efficiency; the toper and the ne'er-do-weel would therefore, by the inexorable law of gravity, find their proper level, and the worker anxious to master his position would be rewarded according to the execution put forth. Whilst a premium placed on efficiency is necessarily a process in the law of the survival of the fittest, it is humanitarianism in that it gives all a chance to become fit. As in practice there must be degrees of "fitness," so the high rates which are based on merit will reward each degree according to its kind.

Highly paid and highly productive—what vistas do not open out at these thoughts! Workers of such calibre would recognise in greater measure an employer's liabilities; recognising the keenness of competition, they would nerve themselves for the strenuous fight and in so doing bring into play every faculty of mind and body. Economical management will meet competition by the formation of such a body of workers; the fallacy of rate cutting will not be adopted, but cost will be lowered by increasing the quantity and quality of the product. The sympathetic hand extended by the management, when grasped by the worker's, forms a bond for mutual advantage and advance. Industrial difficulties lend themselves to ready solution when each side can to some extent look from the other's standpoint.

Possibly the chief difficulty in the adoption of high rates lies in the present far-reaching system of uniform rates. The latter have a tendency to level downwards rather than upwards; hence uniform rates tend to develope uniform mediocrity. Assuming trade-union restrictions to be absent and high rates based on high productive capacity to be adopted, then this level of mediocrity slowly but most surely changes into one of efficiency. A further question arises in that, supposing high rates to be universally adopted (a rather untenable supposition) will they not lead to uniformity and its resultant mediocrity? No, the high rate used as an incentive to greater effort can not result in uniformity, for it will always tend to draw out all that is best in the recipients. No worker can have greater incentive to greater effort than the certain knowledge that his strenuousness will be rewarded in kind. It is true that from a certain section of workers the introduction of the high rate would meet with opposition, or rather they would strongly object to the necessary correlative of high production. The home surroundings which develope this attitude of objection have to some extent been examined in an earlier issue of this Magazine.* A further cause may lie in the systematic rate cutting practiced by an occasional firm working on a piece-work basis. In cases of this kind rates are cut because an efficient worker exceeds a certain maximum—a practice which, when recognised by the workers, results in the restriction of their output and brings out a spirit of distrust against any and all new methods proposed by the management. To overcome this spirit of distrust and suspicion the management must be firm in the insistence of the underlying principle of the high rate—that of a low cost of production. If the worker knows certainly that increased production means increased pay, and that no matter how high a sum he may earn, provided his production corresponds to his pay, the rate will not be cut—then in very truth he has strong inducement to work to full capacity. The educative effect of the higher rates already referred to will go far to remove these and other difficulties of the industrial world.

The economy of a high rate is generally recognised in positions of trust; for instance, the general manager of a large concern is not selected because he may be the cheapest man but rather for his efficiency. Indeed, all experience goes to prove that in the end the best obtainable is in every case the most economical.

Therefore if it be wiser to have a skilled doctor and an expert lawyer, if it be of more pleasure to listen to a prima donna than an artiste of fourth or fifth rate, it it be of more profit to have the services of a good tailor and a first class cook, will it not also prove economical to have the service of efficient workmen—even though their rate may be high?

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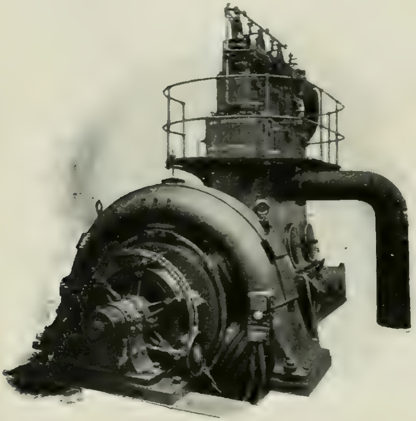
* The Home Environment of British Workingmen. Percy Longmuir. THE ENGINEERING MAGAZINE, January and March, 1902.

# ELECTRICITY IN MODERN STEEL MAKING.

*By John Hays Smith.*

**In the literature of engineering, a peculiar value is attached to the actual description of what has been done, tested, and proved good. This quality of definiteness and concreteness is markedly present in Mr. Smith's account of the utilization of electricity in one of the most famous steel works in the world.—The Editors.**



FROM the window of the swiftly flying Pullman, when some miles east of Pittsburg, the traveler gets a hasty view of a long line of blast furnaces half veiled in murky smoke and steam, a glimpse of swiftly moving red-hot bodies that pass within the buildings in the foreground, and a momentary view of a lashing yellow flame suggestive of Vesuvius or Mount Pelée. This is the famous Edgar Thomson Steel Works, the largest rail-making establishment in the world, and an integral part of the Carnegie Steel Company, which has recently been merged into the United States Steel Corporation. It was here that Andrew Carnegie first made a success of the steel business.

The Edgar Thomson plant is designed and arranged solely for the manufacture of Bessemer steel rails. The process is continuous from the time the ore is dropped into the furnace top until it is transmuted into its final form—a finished rail. The material, through all the intermediate processes, is never permitted to grow cold. The white-hot iron drawn from the furnace is carried in great vessels to the Bessemer house where it is transformed into steel. The molten steel is cast into ingots and then rolled into rails. All this takes place by a series of closely related processes, marvelous in the facility with which they are completed and wonderful for the fewness of men required to carry them out.

When all nine blast furnaces are in operation they produce sufficient metal to make 2,200 tons of finished rails each day, or enough to

GENERAL VIEW OF THE EDGAR THOMSON STEEL WORKS.

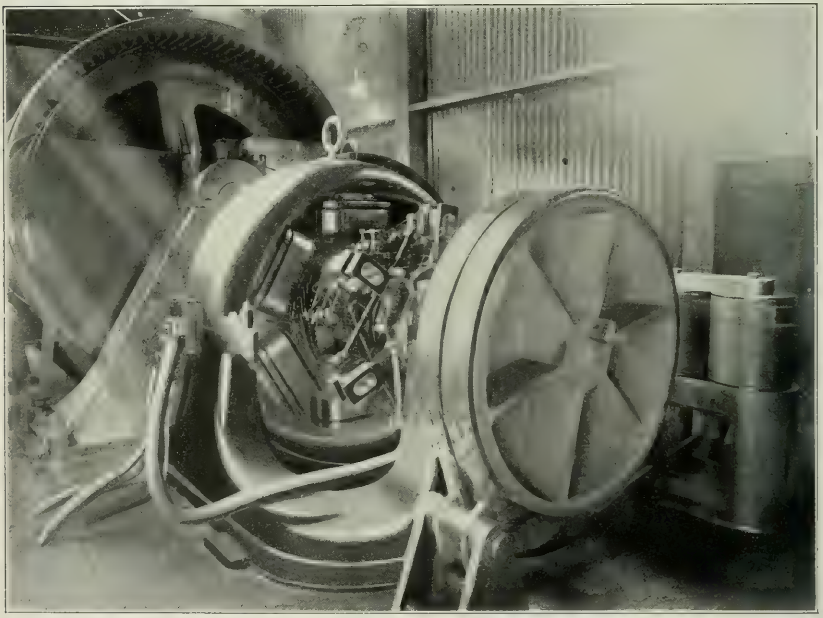
lay 12½ miles of single track with the heaviest rails that are made—one hundred pounds to the yard. Figures give but an inadequate idea of the production of the works. A year's output is more than sufficient to lay a single track railway across the United States from ocean to ocean. In the twenty years of operation there have been produced more than 200,000 miles of rails, sufficient for thirty tracks side by side from New York to San Francisco.

One of the most potent factors in the development of these works has been the use of electrical apparatus. A modern central station distributes electricity to the various machines, formerly driven by small steam engines. Steam was then supplied by long leaky pipe lines, and the loss of heat by radiation was very large and the condensation of water in the pipes troublesome. Now, a few slender wires replace the large and cumbersome steam pipes, and at the end of the transmission line an electric motor supplants the steam engine.

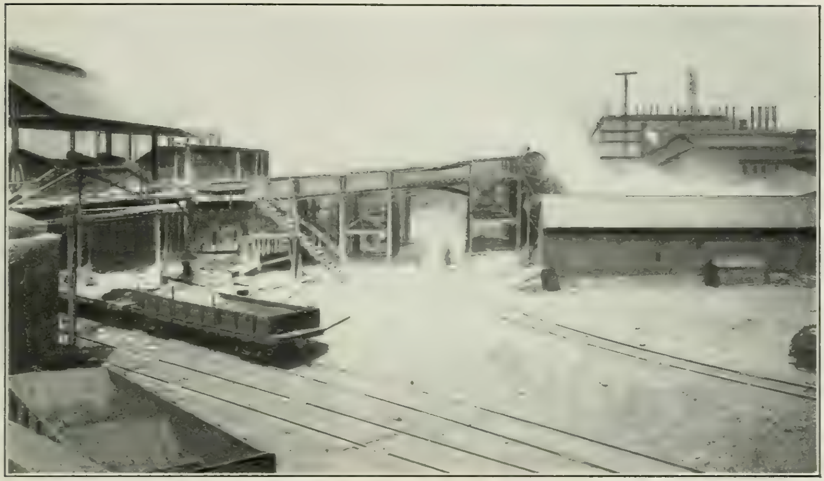
The introduction of electricity in rail making and the substitution of the electric motor for the steam engine have largely come about through the far-sightedness of George Westinghouse and the enterprise of Charles M. Schwab. In the operation of natural causes constantly at work revolutionizing American industries, capital has been plenty and labor always costly as compared with European labor and capital engaged in the same industry. In America neither brains nor money has been spared in the endeavor to cut down the labor item, either by the entire substitution of mechanical processes, or by the improvement of rough devices already employed. Even the best known method of doing a thing has never been sufficient to the American manufacturer. He must always have a better method—one that makes a better article, saleable at an increased price, or the same thing at a reduced cost; in either case a larger profit.

The Edgar Thomson works, without adding to its equipment for rail-handling, has greatly increased its output during the past five years. This enlarged production has been made possible by using electricity to operate the various metal saws, roll tables, cranes, rail conveyors, and machine tools. In adopting electrical inventions (the machinery is almost all of Westinghouse make), two paramount considerations have governed—reliability in service, and the increase of output with greatly decreased labor costs. It was desired to make the operations as nearly automatic as possible. Reliability was therefore of the first importance in this manufacturing establishment where the cessation of a single operation in a series of related processes means the shut down, or at least the crippling, of an entire plant.

To obtain a clear understanding of the part that electricity plays in



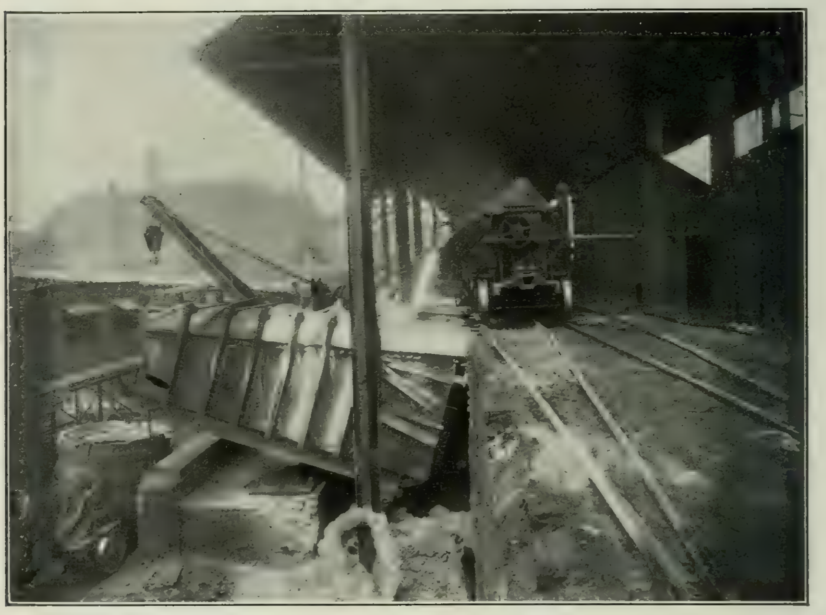
ELECTRIC MOTOR HOIST, ELEVATING ORE, COKE, AND LIMESTONE TO THE TOP OF THE BLAST FURNACE.



PIG-CASTING MACHINE DRIVEN BY ELECTRIC MOTORS.

the process of rail making, the onward movement of the raw material, the metal, and finally the rail, must be followed. The point of departure is the ore yard. Beyond the great mass of iron ore that steamers and railroads have transported from the Mesaba range, and which has been piled at this spot, stand the furnaces flanked by their stoves. Up the sides of the blast furnaces, by an almost vertical incline, pass swiftly moving cars carrying the ore, coke, and limestone in the exact proportions requisite for the production of iron. Electric motors hoist and dump the contents of these cars into the furnace top. Two thousand tons of material are poured into each furnace daily, and yet a single man at the hoist represents the only human agency connected with the lifting, tipping, and returning of the cars.

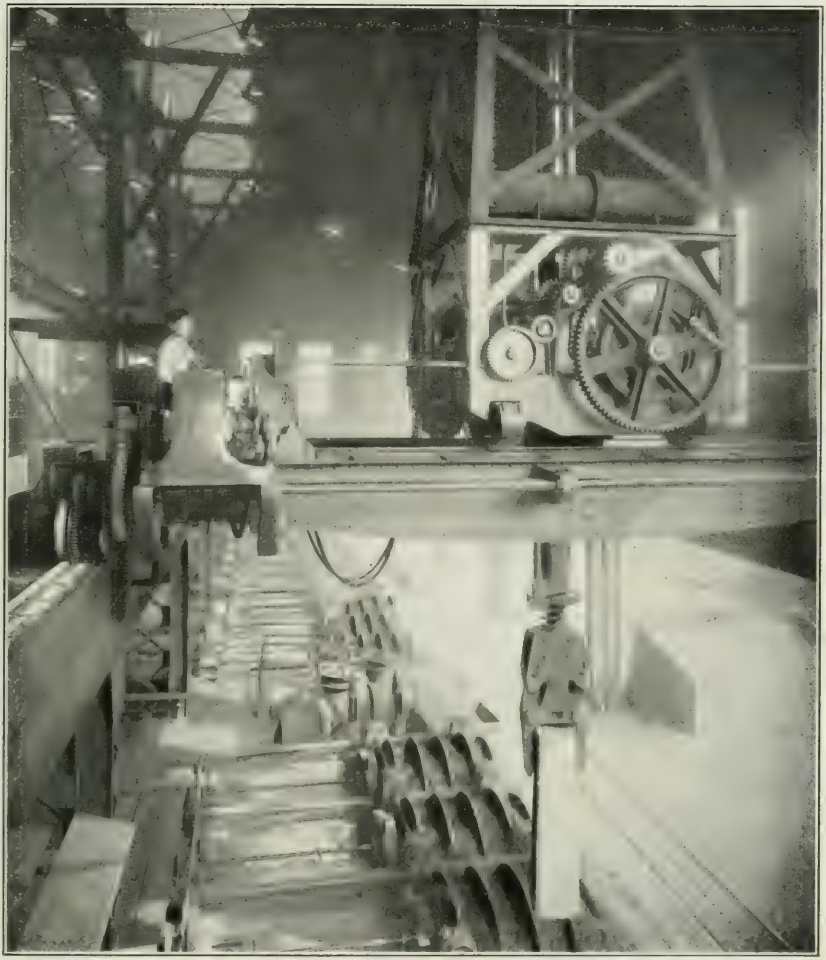
Formerly the molten metal from the furnace was run into sand moulds, requiring for the casting a large space over which a rather pretentious shed was erected. The present operation of casting is striking and if the time of casting be night, the cast-house is the scene of a most magnificent spectacle. A few workmen tap the furnaces to waiting cars on the track outside. Each furnace is tapped every three hours, but the times are so arranged at the nine furnaces that every twenty minutes a train load of metal is hurried off to one of the two "mixers" shown in the accompanying illustration. These are large boxes of peculiar construction and exceptional strength, into which the metal from the various furnaces is poured from the metal cars, for the purpose of making a mixture uniform in quality. The pouring is accomplished by an electric motor placed within the house to the right and tilting the car by means of the turning bar reaching out from the house to the metal car. The enormous tanks of liquid metal are also tilted by an electric motor and their contents poured into other metal cars standing below. With an envelope of heat overwhelming and stifling, this second train of rocking, metal-splashing cars makes its way to the converter house where the metal is refined into Bessemer steel.



ELECTRICALLY OPERATED CAR POURING HOT METAL INTO THE MIXER.

The converter house contains four Bessemer converters. Behind them, fifteen feet from the floor, are the tracks upon which the metal cars arrive from the mixer. It is the work of a moment to couple the electric motor to the turning bar that tilts the car over, discharging its white-hot and liquid metal into the mouth of the converter which has been turned down to receive it. Then back swings the converter with a quickness wonderful for such a ponderous vessel.

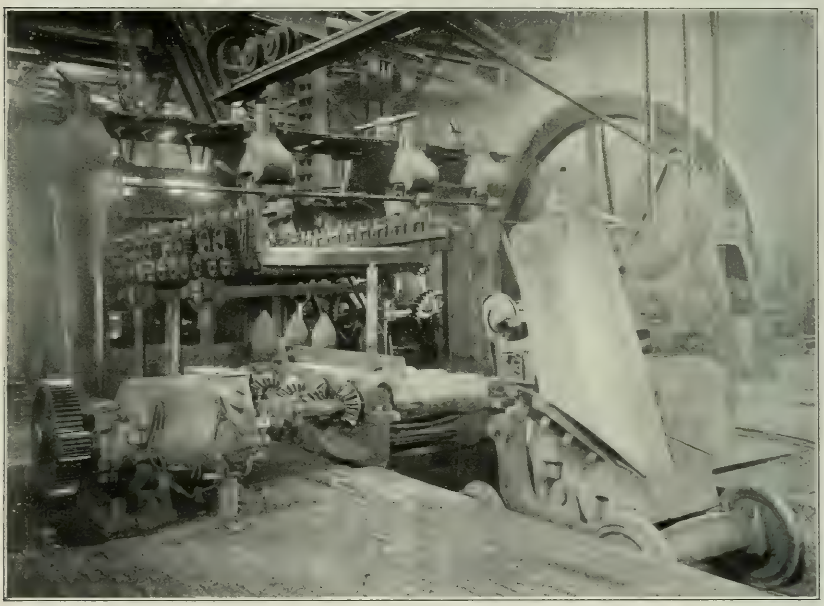
When the blow is completed, a great ladle receives the metal and carries it to one side, filling the ingot moulds that stand on small but massive iron cars. As soon as the metal has solidified sufficiently to permit of the removal of the mould, this is lifted off by a machine called the "stripper." The metal mass, now solid on the outside and fast cooling within, is not yet ready for the rolling process. The preparation for the rolling process is almost as important as the process itself.



ELECTRIC TONGS HANDLING INGOTS OVER THE SOAKING PITS.

It has been found by experience that the life of a rail depends very much upon its physical history and, consequently, the rolling process has been very carefully studied in connection with the wear of the rails. The best wearing rails are those which have been rolled from ingots of the same temperature throughout. Therefore, before rolling, the unevenly cooled ingot is brought to a uniform temperature and one best adapted for making a rail of good wearing quality. This is accomplished in reheating furnaces called "soaking pits," partly because of their underground construction and partly because of the heat-soaking process to which the ingots are subjected. The illustration shows them as subterranean furnaces with horizontally opening doors at the top. Along one side is a narrow track over which the metal cars travel to the soaking pits. Above the bank of furnaces are four monster electric tongs always busy in lowering or raising ingots. Beyond the line of furnaces is another line served likewise by electric tongs. The tongs are suspended from a derrick-like car that travels back and forth on the bridge of an electric crane, which runs above the entire line of furnaces. When all four cranes are moving back and forth, now raising and now lowering the white-hot ingots, the eye is fairly dazzled by the complex, swiftly moving cranes, and the flashing ingots with their overpowering heat.

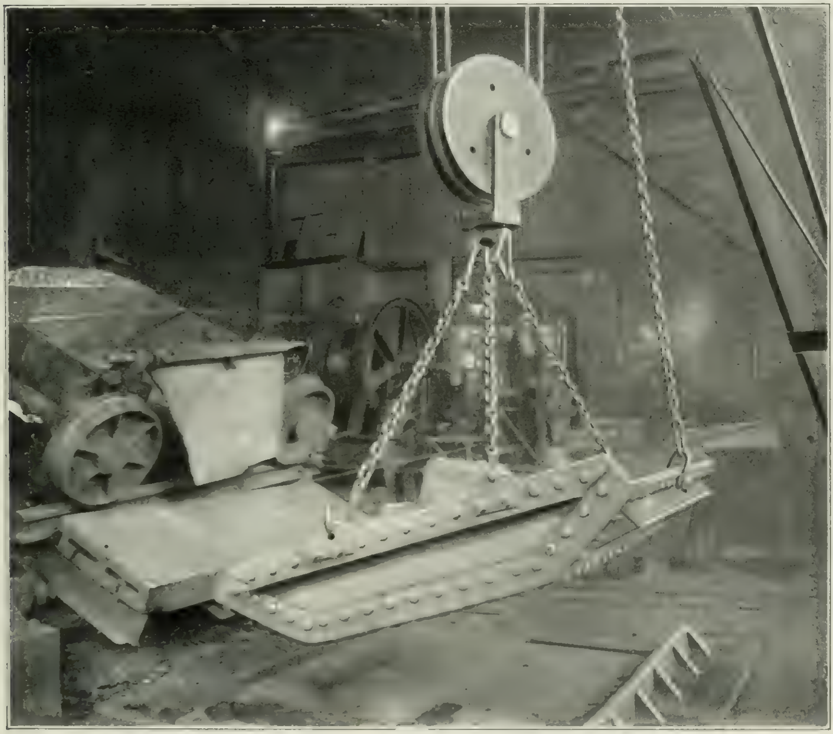
Not only is the ingot hoisted electrically from the soaking pits, but also electrically conveyed to the blooming mill about 100 feet away. The crane man, who operates the monster tongs, places the ingot on an electrically driven buggy. Another attendant quickly sends it off on the latter, bringing it up at the blooming rolls, as seen just above. By a lever the buggy is tilted and the ingot falls on the short train of small rollers ready to be rolled into a bloom. At the will of the same attendant, another motor drives the roll train, carrying the ingots upon the roll table and into the blooming rolls. A powerful engine drives the



BLOOMING MILL, SHOWING INGOT ON ELECTRICALLY OPERATED BUGGY, READY FOR ROLLING.

Motor-driven roll-table and driving motor to the left.

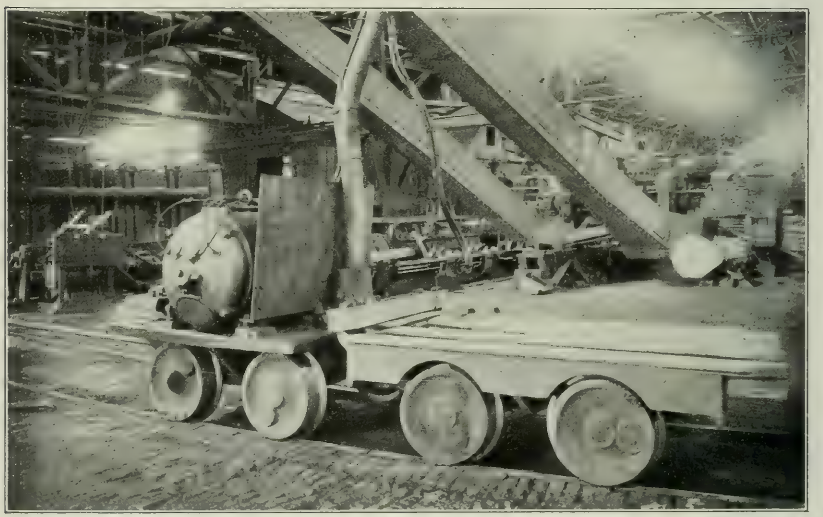
middle roll, which, artificially roughened, catches the metal and squeezes it through. After a number of passes the metal becomes a bloom about 15 feet long and 9 inches square. It has, in the process of rolling, acquired a fibrous structure and is therefore tougher than before rolling.



ELECTRIC MACHINERY HANDLING SCRAP FROM THE BLOOM SHEARS.

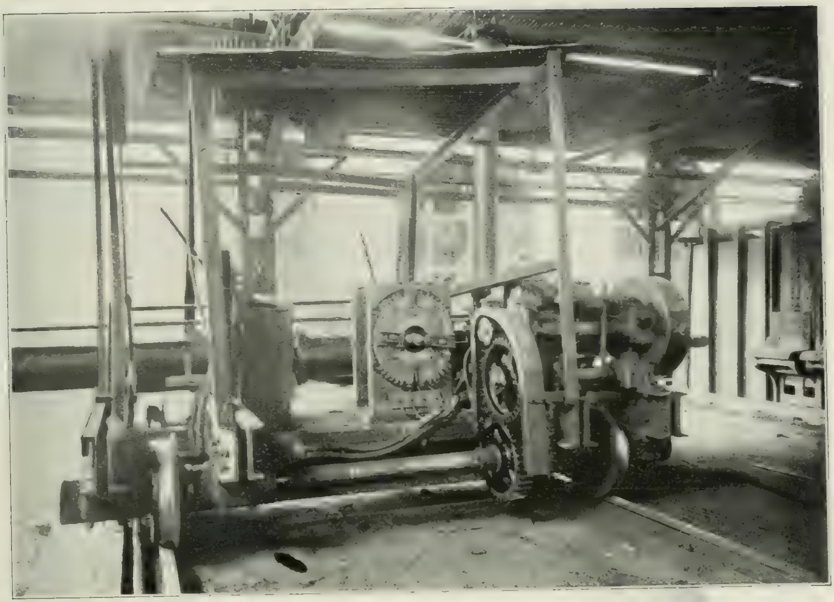
The next process is to cut the long bloom up into small blooms, each of which is afterward rolled out 90 feet to a three-rail length. From the blooming mill, by electrically driven rollers, the bloom passes to electrically driven bloom shears which cut the red-hot steel into sections, of length suitable for rail rolling. The rough ends of the bloom—"crop heads"—are cut off and drop down a chute into a car which from time to time is electrically hoisted up an incline. This "scrap metal" is then placed by an electric crane in a railroad car for shipment to any part of the extensive Carnegie mills. Formerly eight to ten men were employed in wheeling the crop ends out from the bottom of the chute; now a boy with a helper disposes of them. The saving in labor effected at this point of the manufacture is not considerable in itself, but the arrangement illustrates in a pointed manner the methods used in bringing about a cheapened production of steel rails.

Before the sheared bloom is finally rolled into rails, it is again placed in a reheating furnace. The electrical arrangement used in conveying the bloom from the shears to the furnace is unique and to the casual observer somewhat mysterious in operation. From the shears to the extreme reheating furnace extends a tortuously curved track, perhaps 150 feet in length, over which passes a swiftly moving electric buggy, driven by the motor on the front. The blooms are carried on the car, shown empty in the illustration on this page. Formerly a small locomotive was used in drawing the bloom carriage, but the use of a motor for this purpose has dispensed with the dirty smoking locomotive, and has contributed much toward making this part of the mill clean. When the bloom is brought in front of the proper furnace it is thrust in by a bloom-charging machine standing on a wide track, just outside the bloom-carriage track. The machine shown on the opposite page is electrically driven and carries a long hydraulic plunger for pushing the metal into the furnace.

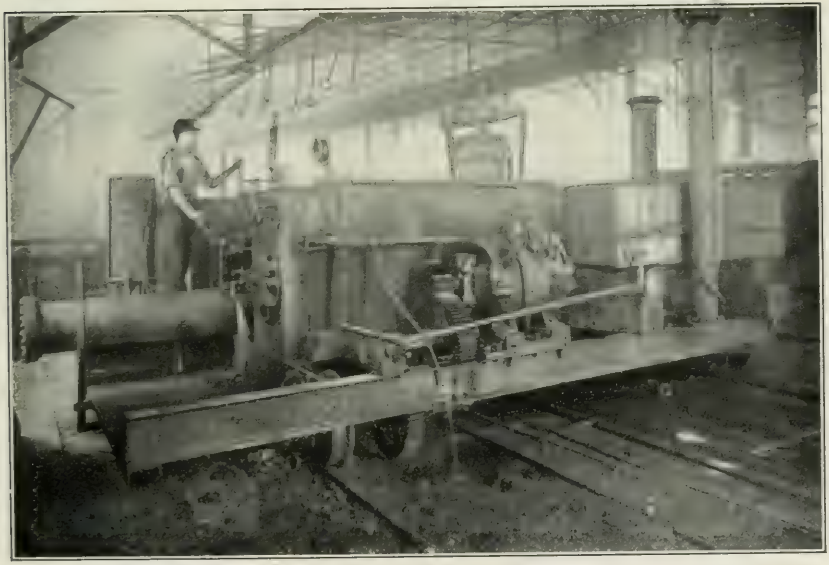


THE MOTOR-DRIVEN BLOOM CARRIAGE.

Above the charging machine is a trolley line, constantly supplied with current; and above the bloom-carriage track is another trolley line which can be electrified at the will of the operator on the charging machine. It is by this means that the bloom carriage is moved. A lever controls the movement of the charging machine in front of the furnace, another lever throws out the plunger thrusting in the bloom.



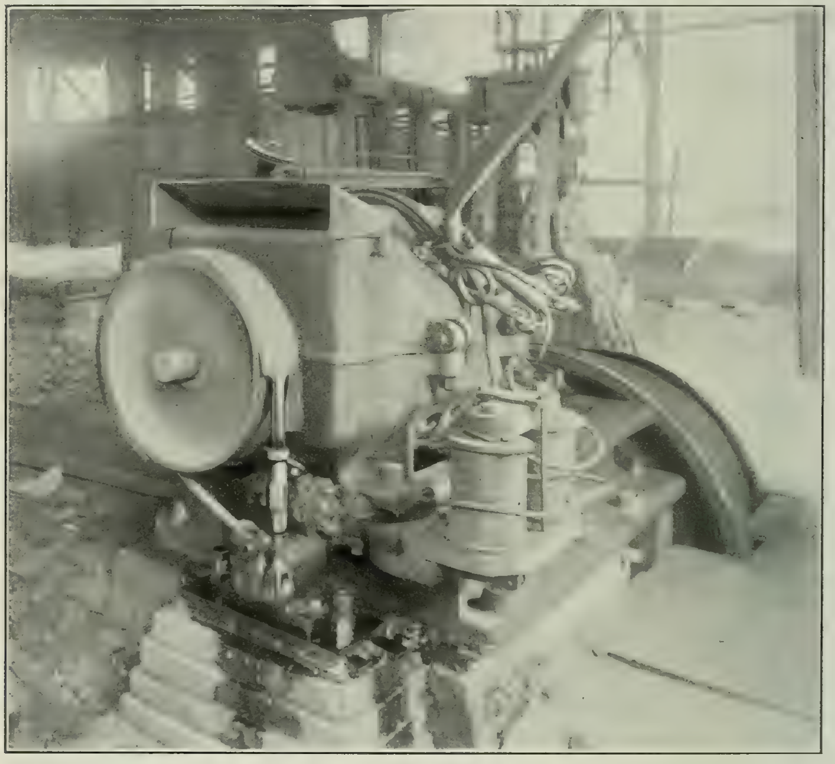
ELECTRICALLY DRIVEN BLOOM-CHARGING MACHINE.



OLD TYPE OF STEAM-ENGINE DRIVEN BLOOM-WITHDRAWING MACHINE.

The boiler and engine shown are no longer used. The motor in the foreground now runs the machine back and forth in front of the furnaces. The photograph is interesting as showing a stage of transition toward the apparatus illustrated just above.

The same operator standing on the electric charger raises the furnace door, while by still another lever he controls the movement of the bloom carriage. Thus a single operator carries for considerable distance a load of blooms weighing in the aggregate a couple of tons, and, unaided, puts them into the furnace. Here again electrical arrangements, labor-saving and most ingenious, testify to the ingenuity of the men who made these mills world-famous.

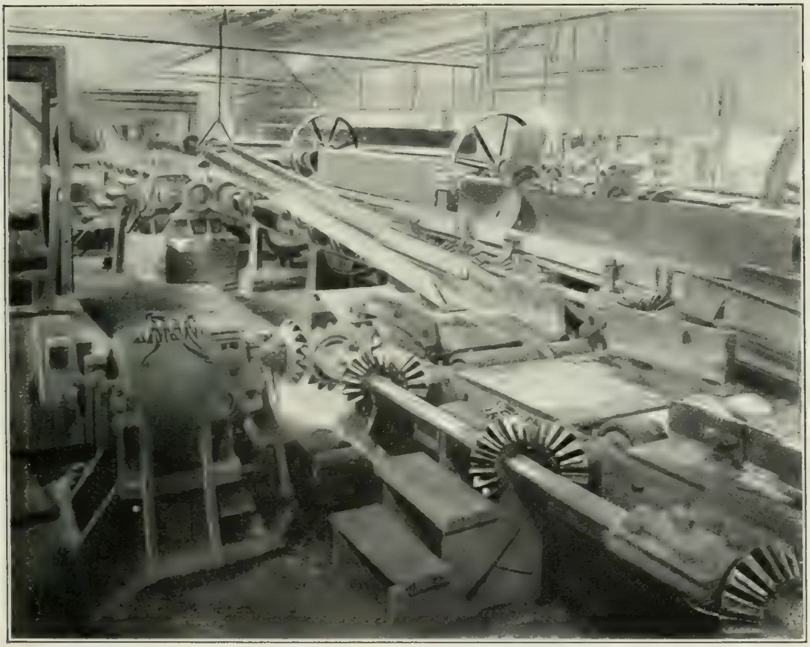


MOTOR WHICH HANDLES REHEATED BLOOMS, HAULING THEM VERY RAPIDLY TO THE RAIL MILL.

The workmen term the bloom carriage a "go devil," although the term is usually applied to the manipulator of the blooming mill. There is something uncanny in its swift, tortuous, and apparently uncontrolled movement, operated as it is by a man who seems to be giving his attention to one machine—the charging buggy—while in reality he divides it between the charging machine and the "go devil."

When a bloom has been reheated, it is drawn from the furnace on the opposite side by an electric "drawer" similar in every respect to the charging machine, and deposited on a buggy driven as shown above. It is then carried to the rail mill, where the transfer to the rolls is effected by a line of electrically driven rollers. Here begins the final process—the making of the rail. The shaping is by iron hands. The workmen are few in number and in the strict sense of the word not workmen; they only direct the movements of complex and ponderous machinery.

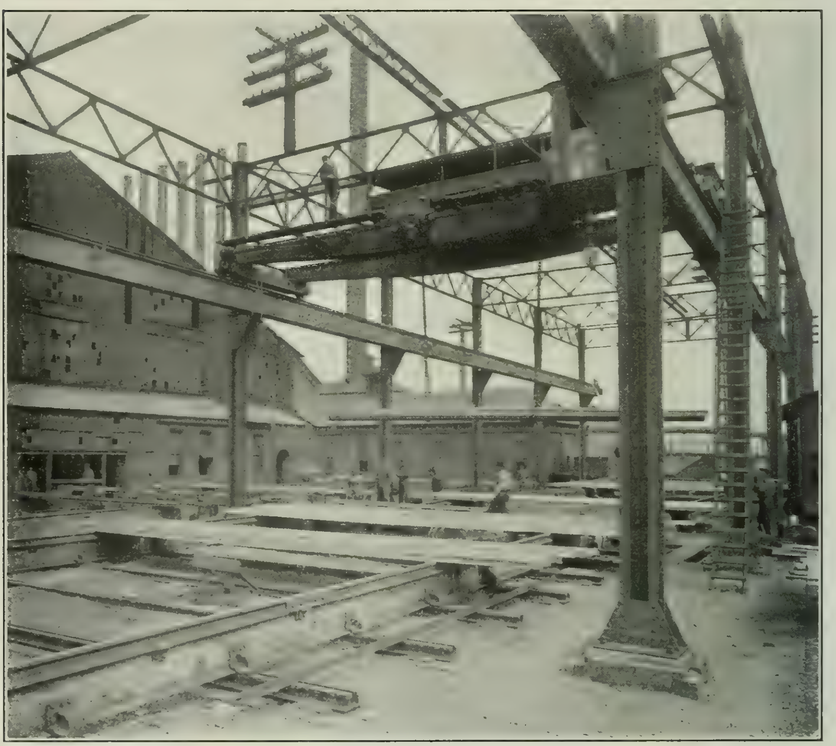
Everything except the heavy rolls that shape the steel is electrically operated by the mere movement of levers. The requisites for the work are a sure eye, a prompt hand, and a clear head. In the pulpit that gives a commanding view of the rolling and conveying machinery, and at the various machines, are a few operators. The red-hot steel passes into the rolls and, rushed back and forth on electrically driven rollers, it lengthens with each pass until finally it runs out a thick bar about 30 feet long, when a set of transfer arms picks it up and throws it bodily to a second set of rolls in line with the first set—much as a row of men standing in line would toss a plank back over their heads. In this set of rolls the steel bar, under the gentle press of the roll, quickly reaches a length of 100 feet. Just beyond, a third set of rolls receives the rail and finishes it off into its final and familiar T form.



MOTOR-DRIVEN ROLL TABLES IN THE RAIL MILL.

Showing two of the motors and the manner in which they drive the rollers.

From the finishing rolls, on electric rollers, the long rail passes to the hot saws. A touch of the lever, and rapidly rotating saws, electrically driven, cut the rail in three pieces each 30 feet long. From the saws, the rails pass one at a time to the "curver," a machine that puts a camber into the rail, so that in cooling the rail will settle into approximate straightness. The "curver" puts just as much arch into the rail as gravity can remove during the cooling period. Thus a simple machine obviates much labor that later would be necessarily difficult with a cold rail. From this point the rails pass out on the "hot bed," a skid constructed of rails and provided with electrically moving clutches. In groups of four or five, the rails go to the electric straightening presses, and then finally to electric drill presses that pierce the holes through which the rails are afterwards bonded together. Lastly, a motor-driven rail conveyor carries the finished rails out to the shipping skids. They are ready for the markets of the world.

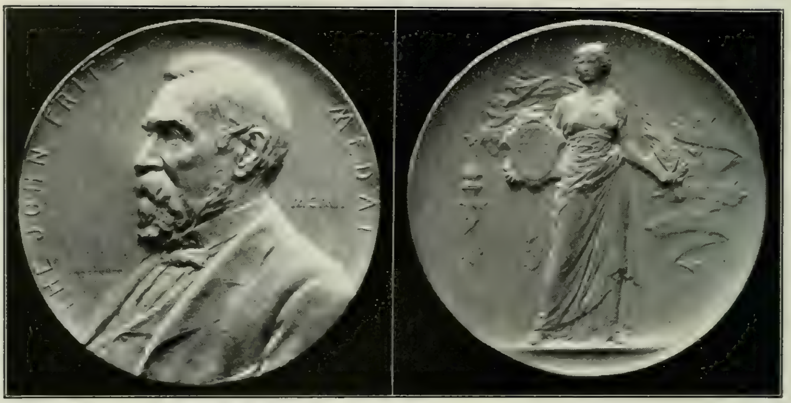


ELECTRIC CRANE LOADING FINISHED RAILS ONTO CARS FOR SHIPMENT.

Electrically driven rollers, leading from the building on the left, bring the rails out from the last finishing process.

ELECTRIC LOCOMOTIVE USED IN HAULING RAILS.

From the beginning to the end of the process, man has not touched the metal. His has merely been the hand guiding gigantic machines. The various furnaces, rolls, conveying devices, and machinery handling the rail, each contribute toward its perfection and final form, and are to be regarded as the parts of a nicely adjusted machine, the harmonious working of which is essential to the completion of the finished product. The various stages of manufacture are closely timed as the movement of a clock. From the time that the ore is lifted from the ore bins until in the form of finished rails it is loaded in the cars for shipment, the process of manufacturing is moving on a time schedule. Electricity is everywhere the vitalizing energy.



# THE FOUNDATION OF THE JOHN FRITZ MEDAL.

*An Editorial Comment.*

IN the establishment of the John Fritz gold medal the engineering profession in the United States has performed an action of two-fold importance; it has honored in a most distinctive manner the name and work of the dean of the profession in America and it has provided an incentive to others to follow in his footsteps.

Founded by the joint action of the four great national engineering societies, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the American Institute of Electrical Engineers, and intrusted forever after to a commission composed of representatives of these four societies, the John Fritz medal in its foundation expresses a remarkable agreement of the profession upon one of the greatest factors in engineering progress, and upon the part Mr. Fritz has borne in the perfection of steel making; in its perpetuation, the honor of its award will constitute the goal toward which the energies of ambitious men in all branches of the profession will be bent.

Born in 1822, Mr. Fritz has been engaged during his long life entirely in the development of the iron and steel industry of the United States. Such a career covers practically all of the developments in iron manufacture since Cort invented the puddling furnace, and all of the tremendous expansion in the manufacture and use of steel which followed the epoch-making inventions of Bessemer, Siemens, Martin, Gilchrist and Thomas.

Mr. Fritz's work has been mainly that of a developer of processes which, while they may have had their origin elsewhere, have found their fullest fruition in the mills, forges, and machine shops of the United States. It was he who with the lamented Holley and with his brother George Fritz, practically initiated America into the possibilities of the Bessemer process, and it is in his footsteps that the men who have since carried on the work have trod. Under his masterful, conservative, comprehensive guidance there have grown up in the United States such works as those at Johnstown and at Bethlehem, with all the development of the modern three-high rolling mill, the hydraulic forging press, the nickel-steel armor plant, gun forgings, structural-steel production, and the whole transformation of modern materials of engineering; and today he stands as the concrete representative of modern engineering in all its highest achievements.

Mr. Fritz has had the rare privilege of receiving in his lifetime the honors which too often come only when they can no longer be a gratification. He has been successively president of the American Institute of Mining Engineers, and of the American Society of Mechanical Engineers. He is an honorary member of the Franklin Institute, and the honored recipient of the Bessemer medal at the hands of the British Iron and Steel Institute.

Perhaps no better summary of the work in which Mr. Fritz has taken such a controlling part can be made than to quote from his own Presidential Address before the American Society of Mechanical Engineers, delivered in 1896.

> "The modern practice of steel making has, in the hands of the mechanical engineer, the metallurgist, and the chemist, wrought wonders in producing a material which in quantity, physical qualities, and cheapness would have been regarded as utterly impossible half a century ago, when steel rails, beams, angles, and plates were not thought of, and steel was regarded as a luxury among the materials of the working artisan. The labor of the men of iron and steel has so cheapened their products that to-day we are enabled to use steel for the commonest purposes as well as for the most expensive articles produced by the skill of the mechanic. No article is too humble to be made of it, and no structure so grand and important as to refuse its services; it is demanded in the frying pan as well as in vast bridges and viaducts, as well in the housewife's needle as in the great leviathans which have made the ocean a span of less than a week; thus we find steel asserting its value through every walk of life, and extending to every clime, linking lands in that bond which grows broader and stronger with the years, till even now we see, if but dimly, on the horizon the promise of the linking of nations in the universal brotherhood of mankind, and bringing the longed-for era of eternal peace."

And then, at the close of his eloquent address, Mr. Fritz might well have added, had his gentle and characteristic modesty not deterred him: *"quorum pars magna fui."*

# THE PREVENTION OF ACCIDENTS TO WORKMEN IN FRANCE.

### *By Jacques Boyer.*

**The protection of workmen from injury while in the performance of their duty has been made a subject of frequent legislation in France, besides which the important Association des Industriels de France has taken an active part in the work by its publications, its inspectors, and its expert engineering advice. Professor Boyer gives a *résumé* of the historical side of the subject, with some account of its present status in France, and the experience thus gained should be of value to employer and employee alike in other countries.—The Editors.**

IN France, before the Revolution, the control of each industry was delegated by royal authority to the various municipalities, and no workman was permitted to ply his trade in any locality without being registered in the local corporation. The Constituent Assembly abolished this restrictive policy, and in 1791 proclaimed the freedom of labour, after which the law of 22 Germinal, in the year XI of the Revolutionary Calendar (11 April, 1803) was passed to determine the respective obligations of workmen and employers. Not long afterward, in 1806, an ordinance of the prefect of police limited the duration of the working day upon building work in Paris. Finally, in 1841, the regulation of industrial conditions was seriously undertaken. According to a law passed in the latter year the age of admission for children was fixed at a minimum of 8 years in all workshops, factories, and metallurgical establishments. According as the age of the children ranged between 8 and 12 years, or 12 and 16 years, the length of the working day was fixed at 8 and 12 hours respectively.

The laws of 1848, 1851, and 1874 made successive modifications in these regulations, until the subject reached its present status by the law of November 2, 1892, modified in certain articles by the enactment of March 30, 1900, and by the decrees provided for its execution. So far as the regulations for the assurance of hygienic conditions for workmen provided in the law of June 12, 1893, are concerned, they will also be considered in their proper place.

According to the enactments at present in force, children may not be employed in workshops, mines, mills, or factories before they have attained the age of 13 years. For children, minor girls, and women, the maximum length of the working day was fixed at 11 hours, but since the beginning of 1902 this has been reduced to 10½ hours, and after a period of two years it is to be reduced still further to 10 hours.

Children under 18 years of age, and women, are required to have one day off in each week. With the exception of mines and of establishments in which furnaces are maintained in continuous operation, the hours allotted to repose are required to be the same for the entire working force, in order that the household life of the families may be maintained.

The inspection service is uniform over the entire country. There are eleven division inspectors, with salaries ranging from 6,000 to 8,000 francs, and ninety-two departmental inspectors, with salaries from 3,000 to 5,000 francs. In addition to these there is a superior commission, composed of nine persons, these being two senators, two deputies, and five members, appointed for a period of four years by the President of the Republic. This commission is charged with the duty of maintaining a vigilant enforcement of the laws and also of passing opinions upon questions which may come up for discussion in the same connection. In case of any violation of the laws of 1892-1900, the employer is subjected to a fine of 5 to 15 francs. A repetition of the offense renders him liable to a further fine of 16 to 100 francs. The maximum fine which can be inflicted is 2,000 francs, under certain provisions of the law of 1893. Finally, if the proprietor of an establishment, after a second warning, fails to comply with the measures of security or health imposed by the inspector, the commission is empowered by law to close the works.

General Requirements for Safety in Workshops.—Experience has suggested to French legislators certain regulations as advisable in connection with the construction of industrial establishments, and these will be briefly passed in review. The most important of these relate to the dangers from fire, the conditions concerning which vary according to the nature of the industry. Many new factory buildings are constructed in reinforced concrete, which appears especially well adapted to prevent the propagation of fire. These combinations of iron and masonry are good, provided sufficient play is provided for the expansion of the metallic portions under the action of heat; otherwise there may be danger of rupture and collapse. In all cases the buildings are required to be provided with standpipes, fitted with valves and lengths of hose, for the delivery of water under pressure, the hose being placed in closets provided with glass doors.

Various systems of extinguishers are used in French workshops, the principal form being the Labbé grenade. Nearly all these devices are based on the same principle, that of discharging into the midst of the fire a mixture of water and carbonic acid, or of a saline solution possessing similar properties. The contact of the liquid with the burning material generates an atmosphere which will not support combustion and at the same time isolates it from contact with the oxygen of the air.

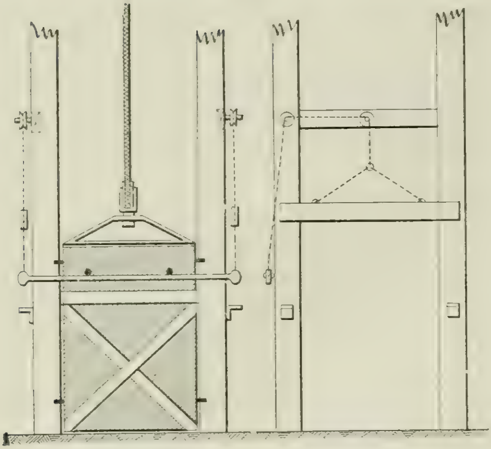


FIG. I. AUTOMATIC SAFETY GATES FOR FACTORY HOIST.

Exits from workshops should always be provided with doors opening outward, and the passageways should never be permitted to be encumbered with merchandise, it being required to maintain always an opportunity for rapid exit of the employees in case of alarm. Stairways should be ample in number, and made both large and strong. If the factory consists of several floors, security demands that there shall be at least one stairway of non-combustible construction, and this rule has been formally imposed by a decision of the Minister of Commerce, upon the advice of the committee of arts and manufactures.

Passageways between machines, tools, or other pieces of mechanism should never be less than 80 centimetres (31½ inches) in width. In chemical works especial attention should be provided to prevent accidents from workmen falling into vats, tanks, evaporating pans, or other vessels containing corrosive liquids, this requiring that they be enclosed with railings not less than 90 centimetres high (35½ inches), the rims of the vessels also being made high whenever practicable.

Elevators and hoists of every kind are frequent sources of accidents. In order to prevent accidents by reason of workmen falling down the shafts, the doors should always be kept closed on every floor, except when the cage is opposite, and this is best accomplished by some form of automatic device. This is readily accomplished for the top floor by providing a trap door which is opened by the cage itself, and closes down upon it in descending, while for the ground floor sliding gates operated by chains, as shown in Figure 1, may be conveniently used. For the intermediate floors various devices may be used according to local conditions. In Figure 2 is shown an arrangement frequently employed. On each side of the cage is fixed a bent bar A. A lever B is hinged to the bar A at b, and is also connected to it by a helical spring R, extending from a to c. The doors on each floor are arranged to slide vertically, and are provided with projections E, of sufficient length to engage with the end of the lever B. The doors are counterbalanced to such an extent as to leave a slight preponderance to close them. When the cage rises the levers B engage with the projections E, and the door is lifted, the strength of the spring being somewhat greater than the unbalanced weight of the door. When the cage descends the door is lowered. If the cage continues to ascend the movement of the door is checked by stops and the extension of the spring R permits the lever B to pass the projection E, and the door descends. In descending, the lever B is lifted as it passes each door by contact with the projection E.

Motive Power and Transmission.—In manufacturing establishments in France a special room, usually of ample size, is generally reserved for the prime movers, either steam or gas engines, sufficient space being given for the engineer to obtain complete access to every part of the machine barred to the general public. Hydraulic motors are also usually placed in a separate compartment whenever possible, railings being placed on either side of the entrance and discharge flumes, as well as on both sides of the passageway leading to the regulating gates. Turbines are naturally always enclosed.

Cranks and connecting rods are often the causes of serious accidents if they are not enclosed in railed spaces, and it is customary to provide such guards that accidents can occur only through foolhardiness. When the two portions of a transmission shaft are intended to be coupled or uncoupled at will, some form of clutch gearing must be employed. Various forms of safety clutches have been devised for this purpose, among which may be mentioned the friction pulley of Piat, the clutches of Edmeston and Snyers, and the automatic clutch of Brancher. A typical devise is the clutch of M. L. Barral, in which the friction blocks are operated by the differential angular movement of the

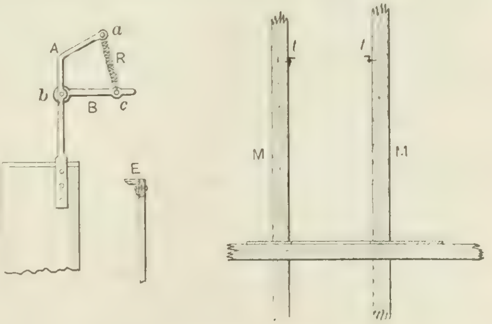


FIG. 2. AUTOMATIC OPERATION OF ELEVATOR GATES.

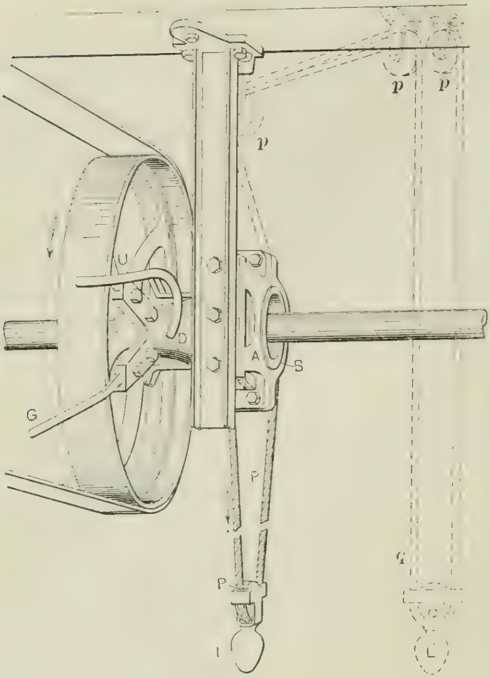


FIG. 3. PIAT BELT SHIFTER.

two shafts until the coupling is effected.

Pulleys which are placed but a small distance above the floor must be protected by being boxed in. Vertical belts should be entirely enclosed in casings of wood or sheet iron. Horizontal belts should be protected so that accidents may not occur in case of their rupture, this being the only danger which need be guarded against, the simplest plan being to place beneath them a shield suspended from the ceiling, or supported from the floor or from the walls.

When a horizontal shaft passes beneath a staircase the belts may be protected by an enclosure extending from the ground and enclosing the pulleys.

The handling of belts may become the source of serious accidents and hence numerous devices have been employed to permit them to be managed in safety. I may here indicate the principal methods employed, according to the excellent work "*La Securité du Travail dans l'Industrie*," by M. Paul Razous, departmental inspector.*

For shifting light belts a simple pole with fork may be used. For heavier belts this cannot be employed with safety, and some form of belt shifter must be mounted by the side of the pulley. A number of such devices have been constructed, among which may be enumerated those of Biedermann, Baudoin, Brancher, Piat, Forest, etc., etc. As an illustration I may describe the usual construction of the firm of Piat. This apparatus, Figure 3, which is intended for belts not exceeding 8 to 9 centimetres in width (3 to 3½ inches), is composed of a sleeve carried by collars A, B, and operated by an endless cord P. Two wrought-iron arms, U and G, are used, one to unship the belt and the other to replace it on the pulley. The operation is as follows: The belt being off the pulley, a partial revolution of the sleeve may be made by pulling upon one part of the cord, while the other part is held taut in order to maintain sufficient frictional contact. As a result of this movement the arm G leaves the belt, which is picked up by arm U, and delivered to the pulley. The belt is unshipped from the pulley in a similar manner.

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* Paul Razous. *La Securité du Travail dans l'Industrie.* Paris, Ch. Dunod. In the course of this article I have had several occasions to use this remarkable book, written by an official who has had excellent opportunities of obtaining authoritative information concerning the methods employed in France for the prevention of accidents in workshops and factories.

The methods employed to prevent the bursting of grind-stones, emery wheels, and fly wheels are now generally designed in view of the provisions of the act of March 10, 1894. In the case of ordinary grind-stones, used for sharpening tools and revolving at a moderate speed, there is little or no danger to be apprehended. For wheels of natural or artificial abrasives, employed for polishing or cutting metals and operated at high rotative speeds, the action of centrifugal force must be considered. Since the stresses increase according to the square of the velocity, according to the mass, and to the radius of gyration, these may become enormous at the high rotative speeds frequently used, and may occasion the rupture of the wheels with consequent risk of fatal or serious injury to the operatives. In order to minimise the risk of such accidents the French administration has recommended that the circumferential velocity shall not exceed 13 metres per second, (42.6 feet per second) for natural grind-stones, and 25 metres per second (82 feet) for artificial wheels. Grinding wheels are now frequently made double-conical in shape, as shown in Figure 4, with a greater thickness at the centre than at the circumference, and mounted between two plates under which are washers of felt or rubber. Such wheels usually break across one diameter, and the plates and washers aid in holding the fractured pieces together.

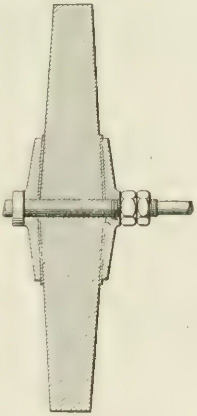
FIG. 4. SAFETY MOUNTING FOR A DOUBLE-CONICAL GRINDING WHEEL.

In order to avoid accidents from the bursting of fly wheels, it is necessary to use cast iron of the best quality and to form the rim so as to offer a minimum degree of resistance to the air. In some instances the rims have been built up of wrought iron or steel and in other cases they have been reinforced by a wrapping of steel wire. It is also most important that the engine should be furnished with a reliable regulator, in order that a uniform speed may be maintained and that the engine may not "run away." The Farcot governor, a modification of the original ball governor of Watt, is much used in France, because it is nearly isochronous and maintains a very uniform speed of the engine in spite of great variations in resistance. For high-speed engines, however, shaft governors are generally preferred, the Lecouteux, Garnier, Westinghouse, and others being used.

Another feature of much importance in connection with safety is that of provision for the prompt stoppage of the engine in case of accident, such as that of a workman being caught in a coupling, shaft, wheel, or other part of the machinery. For this purpose it is not unusual to find the various rooms of a factory connected with the engine room by electric annunciators. This provision, however, is not always sufficient. Much precious time may be saved by providing a direct control of the engine from the possible scene of accident, and several devices have been produced for this purpose. Such an apparatus, operated electrically, has been devised by M. Ressenon, and another is made by Dollfus-Mieg & Cie. By pressing a button in any one of the workrooms of an establishment, the following succession of actions is produced:—1, the closing of the steam stop valve; 2, the shutting off of the condensing water; 3, the application of a powerful brake against the fly wheel.

Another method of providing means for suddenly stopping the machinery is that of using some form of connection between the motor and machinery which may be promptly disconnected. For this purpose various forms of clutches are used, the simplest being the ordinary jaw clutch, consisting of one sleeve with projecting teeth fixed upon the driving shaft, and another with similar teeth sliding on a feather on the driven shaft, a lever enabling the latter to be instantly drawn out of engagement. Friction clutches are also employed.

In establishments in which hydraulic power is used it is more difficult to stop the motion suddenly. The only methods in practical use are those of closing the gates by hand, or by the use of clutches for disconnecting the machinery from the wheels. As by far the greater number of hydraulic power plants are also those in which the power is electrically distributed, however, the shutting off of the current by convenient switches is generally available.

In regard to the question of dangers accompanying lubrication of machinery, the French laws specify that whenever possible machinery shall be lubricated when not in motion. If continuous lubrication is necessary it should be effected by automatic devices, which can be replenished when the machines are standing. Trains of gearing should be lubricated only through proper openings provided in the cases in which they are enclosed.

The Guarding of Machine Tools.—Having considered the principal methods of preventing accidents in connection with the motive power machinery, it remains to consider the principal tools and machines themselves; referring especially to methods and appliances used in France.

In wood-working establishments especial attention should be given to circulars saws, band saws, and hand jointing machines, or hand planers, as the latter are sometimes called. The accidents occasioned by circular saws are due either to the contact of some portion of the body of the operator with the teeth of the saw, or to the projection of pieces of wood back over the top of the saw. The latter class of injuries is not at all uncommon, the short ends cut off by the saw catching in the teeth and being thrown back with great force against the head of the operator, frequently with fatal results. Accidents from cutting are best prevented by surrounding the saw with some form of guard, while at the same time it is advisable to make it very convenient to stop the saw readily, in order to remove the temptation to clear away sawdust with the hand while the saw is running.

Accidents due to the projection of pieces over the saw may be prevented by arranging a dividing blade by the side of the saw, back of the centre, so as to guide the cut off piece away from contact with the saw teeth. A heavy plank, suspended from the ceiling in front of the workman, may be made of such a length as to permit unobstructed vision of the work, and yet furnish complete protection against flying blocks.

In view of the numerous accidents from cutting by circular saws, the *Association des Industriels de France* instituted a competition for the design of a satisfactory form of safety hood. The conditions required that the protecting device should permit pieces to be sawed readily, either longitudinally or across the length, and that it should operate automatically, both as a guard against cutting the operative and against injury from projected blocks. Numerous inventions have been submitted in consequence, and from the report of M. Mamy, the director of the association, is taken the description of the apparatus of M. Fleuret, which received one of the awards in the competition. The Fleuret safety hood, Figure 5, consists of two arms, G and H, hinged upon the same pivot O, mounted in the slot S, of the support S.

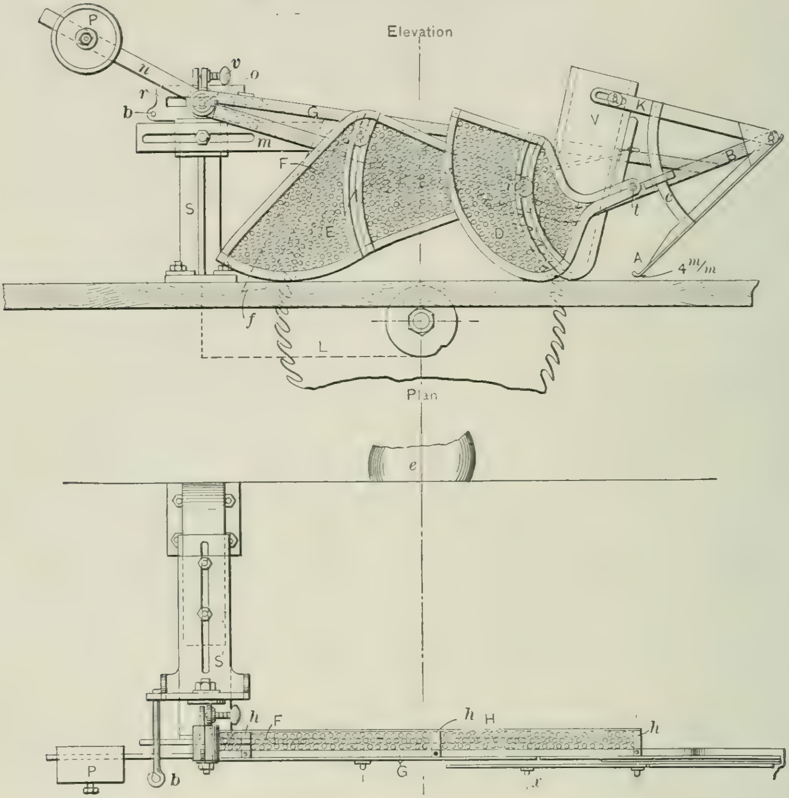

FIG. 5. PLAN AND ELEVATION OF FLEURET SAFETY HOOD FOR CIRCULAR SAWS.

the arms being connected by a piece of perforated sheet iron. The extremity of one of the arms, B, carries a sort of jointed angle K, similar to a pair of compasses, guided by an arc c. The extremity of K carries a slotted piece engaging with a pin on the slide V. The first screen d, made of a frame of iron covered with perforated sheet metal, oscillates about the point t, its movement being guided by the quadrant and pin x, which latter serves as a point of suspension of a second screen E. The dividing knife F, attached to a flat iron bar m, is so adjusted that it enters into the line of cut of the saw. The various parts are provided with adjustments, so that they can be adapted to the saw which may be in use. The action of the apparatus is as follows:—The entering piece of wood raises the foot A, and thus lifts the slide V, this latter then resting on the piece until it is nearly cut through. The screens D and E., are successively lifted by the piece to be cut, so that at no time are the teeth of the saw exposed where they can be brought in contact with any part of the body of the operator. The pressure slide V and both of the screens thus have their movements controlled entirely by the action of the work, and no especial attention is demanded of the workman. The dividing knife F, separates the loose piece as it is cut off, so that it cannot be caught by the teeth of the saw, and thus danger from projected blocks is avoided.

Band saws may be protected as shown in Figure 6, in which the idle portions of the saw are guarded by the wooden casing A B, while the lower wheel is also boxed in as at C, in order to prevent contact with the feet of the workman. Such a casing also prevents accidents due to the breaking of the saw blade, but it must be arranged so as to interfere as little as possible with the removal and replacement of the blades.

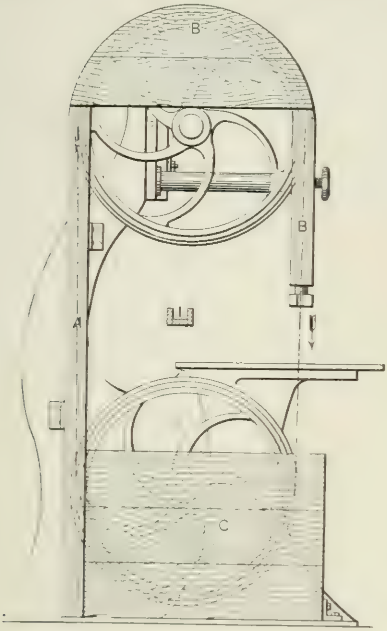

FIG. 6. GUARD FOR BAND SAW.

The jointing machine or hand planer consists essentially of two iron tables, between which is placed a horizontal cutter head revolving at a high rate of speed. The piece of wood is pushed over the cutter head by hand, the depth of the cut being governed by the difference in the level of the two tables. Various arrangements have been made to protect the knives. The Schrader guard is generally used in France; it consists of a curved piece of sheet iron, so arranged that it is pressed tangentially against the piece of wood, effectually covering that portion of the blades which is not beneath the wood.

Vertical moulding machines are frequent sources of serious accidents, and for these the firm of Guillet & Fils, of Paris, have designed a guard containing pressure springs which avoid the necessity of approaching the hands closely to the rapidly revolving cutters.*

In the general machine shop various special forms of protecting devices will be found in connection with lathes, planers, shaping machines, drill presses, and other tools. These usually take the form of screens of wire netting, or of special guards arranged about the tools, but they naturally vary with local conditions and cannot be specifically described here. It will suffice to note that in France the decree of May 13, 1893, provides that children under 16 years of age shall not be permitted to operate shearing machines, or other mechanical cutting tools. The cutting machines used in paper-making establishments, binderies, printing offices, and elsewhere are frequent sources of accidents, the attendants failing to withdraw their hands in time. The best form of precaution is found in so constructing the machine that the knife rises by power and is automatically retained at the highest position, requiring the act of the attendant to cause it to descend.

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* *Collection de Dispositions et d'Appareils Destinés à Eviter les Accidents de Machine.* Mulhouse, 1889. An abstract of this valuable paper will be found in a contribution to this subject by the late John H. Cooper, in the Transactions of the American Society of Mechanical Engineers, Vol. XII, pp. 249-264, 1890.

Electrical Apparatus.—The Association for the Prevention of Accidents of Normandy has prepared instructions for use in connection with electrical apparatus, and these general rules, taken in connection with those of the decree of March 10, 1894, constitute the practice of the industry in France. The principal points included are briefly:

It is required that an insulating layer be placed between the base of a dynamo and its foundation. No dynamo may be placed in a situation where it may be reached by any explosive or inflammable material, except under certain regulations governing its complete enclosure in a wooden casing. Rooms containing accumulators are not permitted to be lighted by arc lamps, since the disengagement of oxygen and hydrogen may lead to an explosion. Such rooms should be provided with a powerful ventilating apparatus, and lighted by incandescent lamps only. Workmen should be provided with rubber gloves and their shoes should have insulating soles.

Switchboards must be separated from the walls of the building by an air space of not less than 8 centimetres. Connections between the dynamos and the switchboard should be insulated, but bare conductors will be permitted if supported upon porcelain insulators, care being taken to keep them at a distance from metallic masses, pipes, etc. Uncovered wires are not permitted by the French Administration for any interior wiring, and the insulated wires must be visible for inspection. This latter requirement is frequently met by placing the wires in accessible wooden conduits in the walls, if the latter are not damp. Conductors carrying a current of more than 10 amperes must be so placed that they cannot come in contact with each other.

Wiring in locations which are necessarily damp requires the use of insulators, and the work must be subjected to constant and rigid inspection. In passing through walls or sills, insulation must always be used. The section of wire should always be proportional to the current, so that overheating may not occur to such an extent as to injure the insulation. Automatic circuit-breakers or safety fuses should be installed, to act whenever the current exceeds 10 amperes, and convenient cut-out switches should be placed where they can be readily operated.

Chemical and Metallurgical Industries.—The principal source of danger in chemical works is found in the various vats and tanks containing hot solutions, or strong acids or alkalies or other corrosive liquids. In such work, apart from any mechanical protection, the careful co-operation of the workmen is essential. The use of special forms of spectacles to protect the eyes, or of respirators and masks to guard against deleterious dust and vapors, should be required. In order to protect operatives from flying glass in the case of the breakage of retorts, these latter should be surrounded with shields of mica, while earthen vessels containing alkalies should be encased in wood.

Factories in which very inflammable substances are made, such as collodion and varnishes, also refineries for petroleum, essences, and other hydrocarbons, should require the operatives to wear special garments, consisting of a blouse coming close up to the neck and fitting closely to the wrists and body, together with trousers of similar material fastened closely at the ankles. For this purpose the woolen fabric known as "lasting" is much used in France, since this is found to ignite with much difficulty, and to cease burning when removed from the flame.

Powder mills, dynamite factories, and other establishments devoted to the manufacture of explosives are regulated very strictly in France. The following restrictions are imposed by law:—The floors are required to be covered with sheet lead. If wood is used in any case the heads of the nails must be imbedded in mastic. Frequent sprinkling and sweeping is also required. The buildings are required to be subdivided to the greatest possible extent, and between them are erected fortifications of sodded earth. In Figure 7 is shown a view of the general arrangement of the dynamite works at Saint Martin de Crau, in the Department of Bouches du Rhône, near Marseilles, giving an excellent idea of the manner in which the buildings are separated and isolated from each other. Before entering the works the workmen are rigorously inspected to see that they have upon their persons no matches, tobacco, or knives, and they are required to remove their shoes and to wear sandals. The explosive substances are worked in the form of pastes as much as possible, and in some cases they are manipulated under water. The sieves and screens are made of fabrics containing no wire and their frames are lined with lead. All depots of powder, dynamite, fulminates or other explosives are required to be strictly separated from rooms containing electrical machinery.

In establishments for the manufacture of chloride of zinc or sulphate of iron, or in which castings or sheets of metal are pickled, as well as in works for the electrolysis of saline solutions, care should be provided for ample ventilation to remove the disengaged hydrogen and avoid explosions. Vapours of bisulphide of carbon are highly explosive when mixed with air, and great care should be taken in cases in which it is involved. At the works of MM. Deiss & Odet, in Paris, this liquid is kept beneath a body of water two metres in depth.

In the vicinity of lime kilns care should be taken against the suffocation of workmen by the disengagement of carbonic acid. In the manufacture of Javelle water or other bleaching materials a most effective ventilation is necessary to remove the fumes of chlorine.

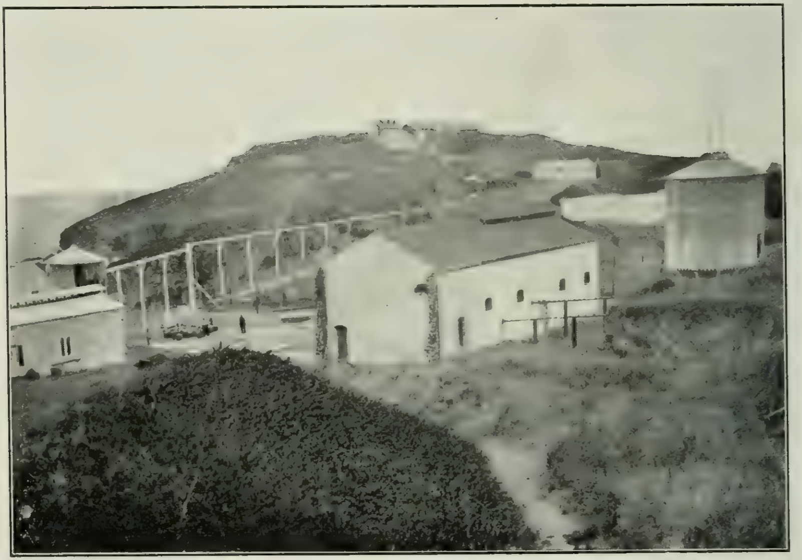

FIG. 7. GENERAL VIEW OF THE DYNAMITE FACTORY OF THE SOCIÉTÉ ANONYME D'EXPLOSIFS, SAINT MARTIN DE CRAU.

The lead chambers used in the manufacture of sulphuric acid are required to be ventilated for 15 days before workmen are permitted to enter, otherwise they might be overcome by the nitrous and sulphurous fumes.

Explosions in blast furnaces may be prevented by providing a valve in the wind main, which may be closed at the moment when the blast is shut off, in order to prevent the return of gas. If the outlet of the furnace is closed, the charging door should be opened when the blast is stopped.

In foundries and forges the principal source of accidents is found in the burning of workmen by molten metal or slag thrown out by agitation or local explosions. The usual protection employed in such works in France consists of a mask of wire gauze and an apron of asbestos cloth.

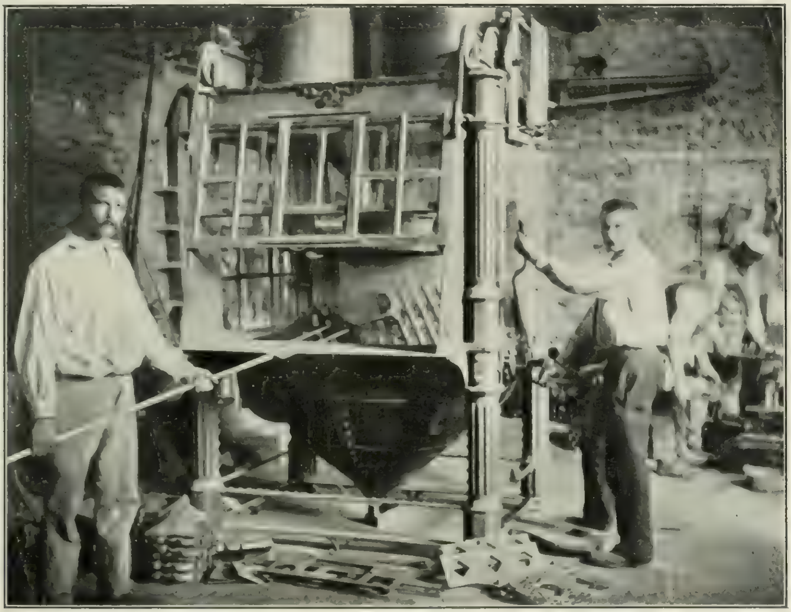

FIG. 8. WORKING OF THE MECHANICAL ENAMELLING MACHINE.

A recent example of a device for the protection of operatives is found in the improved enamelling furnace invented by M. Dormoy, director of the Sougland Works, in the Department of Aisne, for the prevention of lead poisoning of the operatives.* As shown in Figure 8, the apparatus consists principally of a case enclosed on its four sides with glass windows, of a revolving platform, and of a funnel-shaped hopper. Two sliding doors are arranged to be operated by chain gearing, so that they may be readily opened and the pieces to be enamelled introduced promptly. The windows are then closed and the pieces are exposed to the action of the furnace, the enamel being delivered through a special passage, while the fumes are carried off through the chimney.

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* *Le Cosmos,* 50e Année, Nouvelle Serie, No. 845, Paris, 1901.

# EDITORIAL COMMENT

General Abbot's convincing argument for the regulation of the Chagres by the "two-lake plan," which leads this issue, is presented under the conviction that the Panama route will be made fully available—that political obstacles will be removed as engineering uncertainties were, long since—as financial doubts have been by the recent thorough investigations. In spite of the present annoying delay, due to the lack of frankness and lack of plain common-sense in Colombia (or in her representative), our faith remains unshaken that the Panama Canal will finally be built by the United States, because it is the best, and as a nation we cannot afford—and never have been accustomed—to be content with anything but the best.

It is more than likely that Colombia misinterprets her importance in the matter, and is tempted to misuse her supposed power. There was an earlier incident in the financial negotiations which showed how far an over-grasping official could go in his dangerous folly. Fairness on the part of Colombia would beyond any shadow of question be met by not only fairness, but generosity, on the part of the United States; but greed, obstinacy, and shilly-shallying on the part of Colombian politicians should not be allowed long to delay an undertaking which is to meet an urgent need of the whole commercial world. It has been suggested that the interests of a world highway, destined for all time, would justify virtual condemnation proceedings as the effective answer to the obstinate tactics of a petty government which may go down before the work is even begun. The moral justification for such a course seems ample. Colombia's material interests in the State of Panama are at most but the shadow of a shade. Bogotá is farther from Colon in time, and farther still in directness and facilities of travel, than New York. Colombian currency is not current in Panama; Colombian postage stamps are not recognized there. The position of the United States Government shuffling on the doorsteps of the "palace" at Bogotá, seeking rights to confer an enormous benefit upon a distant and loosely-bonded Colombian state, is not pleasant.

* * *

The alternative of dealing with Nicaragua and Costa Rica for the Nicaraguan Canal is of course the one which is loudly urged by the advocates of that route, but it would not be an event bringing much honor or dignity to our country thus to be driven from our purpose by the pettifogging of a small Central American state. And apart from the irreparable loss to the world from the adoption of the inferior route, what would be the reasonable prospect of greater satisfaction in thus putting ourselves in the power, not merely of another, but of *two* other Central American republics, with all rights and concessions, as well as a treaty, to negotiate?

The suggested "condemnation" method sounds effective, but might be difficult in international affairs. And for all practical purposes, what more is needed than the rights and concessions of the Panama Canal Company and the Panama Railroad—which the owners stand ready to sell us, clear and unincumbered, at a price satisfactory to us—backed by our already existing powers and *obligations* to maintain free traffic across the Isthmus? Granted that there is any doubt as to the canal concession now held by the French company, this is subordinate to the railroad concession, which is not clouded by any shadow of doubt, which carries exclusive privilege of trans-isthmian traffic, and which has two-thirds of a century yet to run. If we can police, protect, and control the Isthmus for the French owners of these rights, as we have recently done, have we not all that is practically needed to ensure the same rights should we acquire them?

There seems to be one proposition which can be definitely laid down. That is, that the one "solution" the United States cannot afford to accept is the solution of accepting defeat—the "policy of scuttle"—in its undertaking to build and keep open for the world the best Isthmian waterway.

* * *

THERE appears a rather curious disposition on the part of the daily press, and also on the part of some technical journals which should be above the reproach of such a misrepresentation, to distort that portion of the report of Admiral Melville relating to the personnel bill into a statement that he does not approve of the bill. Thus, for example, so intelligent a publication as *Engineering News*, which should certainly know better, states in plain language: "He condemns the Act of Congress under which every naval officer of the line must become a fighting engineer."

We cannot let such a mis-statement go uncorrected. Admiral Melville says nothing of the sort. He says (we quote from his report to the Secretary of the Navy): "While the personnel law is correct in principle, there is a general feeling among engineers that the purpose and spirit of the measure is not being carried out," and again: "If the law is administered with a desire to make it a success, it will beyond a doubt give us the most efficient navy in the world."

Again: "In making an earnest plea for the complete administration of the personnel law" he says, "No element of personal consideration has influenced my action. I am a convert to, and not an original advocate of, the idea. I am most concerned that engineering efficiency in the navy shall not be sacrificed, and that the great fighting machines, whose motive power has been designed by this Bureau, shall not fail in the work expected of them because they are not properly cared for."

There is every evidence that all the sinister influence of the line officers, indignant that their prerogatives are invaded by the "greasy mechanics," has been exerted in an effort to pervert the public press, and to create an opinion that Admiral Melville is opposed to the enforcement of the personnel bill, while in fact any one who peruses his remarkable report will perceive that his whole contention is that the line officers should be compelled to become engineers, at the penalty of loss of promotion if detected in shirking engine-room service.

Every one who has been familiar with the "line-and-staff" controversy knows how bitter the contention has been, and how strongly the line officers have felt that the personnel bill, passed over their most determined opposition, must be nullified. No opportunity has been lost to convey the idea that the bill has been a failure, and every statement from Admiral Melville, the ablest engineer in the navy, esteemed alike for his professional attainments in naval and civil quarters, has been twisted and turned to make it appear that he is opposed to the bill. He is opposed to its non-enforcement; he is opposed to the efforts of the line officers to continue in the avoidance of engineering duties; he is opposed to all the intrigues which have been set in motion against the bill; but he is fully convinced that "every officer on a modern war-vessel has to be an engineer, whether he wants to or not."

* * *

On October 20 last the Düsseldorf exposition was officially closed with appropriate ceremonies, and it is extremely gratifying to be able to comment upon the conduct of the enterprise as one of the most successful expositions yet held in any country.

While the conditions and character of the exposition render it impossible to make satisfactory comparisons with the great international exhibitions, such as those at Paris or at Chicago, yet size is not the only element to be taken into consideration. The Düsseldorf exposition was notable for at least two things, apart from the brilliancy of the exhibits and the effectiveness of the structures: it was fully ready on the opening day, and it more than paid all its expenses!

The official report of attendance showed 3,056,627 paying visitors, making, with the entrances of the exhibitors and attendants, a total of 4,882,459, while the receipts amounted to 3,184,355 marks. The entire guarantee fund was repaid, with interest, with an estimated surplus of a quarter of a million marks.

Of the technical and industrial importance of the exposition this is not the place to speak at length, since a full account appeared in our October issue, and all the important papers published elsewhere are recorded in the Engineering Index; but its influence upon the development of the engineering industries of the Rhine provinces of Germany cannot fail to be for great and lasting benefit.

A curious criticism recently reached us with reference to the various papers on works organization and factory accounts which have appeared from time to time in our pages. It was complained that these papers were in many cases so abstruse that they required careful studying; that, in fact, it was necessary to sit down in a quiet place and give considerable attention to the subject matter of the papers before their teachings could be thoroughly grasped.

It is difficult to know how to reply to a complaint of this kind, if it is to be treated seriously. How can the presentation of a subject of extreme complexity be other than complex in itself? The Greek philosopher told his royal pupil that there was "no royal road to mathematics." In the same way we might say there is not, and, from the nature of the case, cannot possibly be, any short cut, or journey by easy stages, on the path of modern works organization. The old days when the operations of the largest works could be adequately recorded with a memorandum book and pencil have gone for ever. In their place we have to provide for the registration of the work not only of hundreds of individuals, but of individuals so grouped, and engaged in work so diverse, that systematic integration and analysis is necessary to make the results intelligible and significant.

While sympathizing, therefore, with those old-fashioned persons who look back with a sigh upon the simpler days of their youth, and grumble at the trouble it is necessary to take to grasp the principles of these complex modern systems, it is difficult to see how they can be offered any encouragement. The tendency unquestionably is for manufacturing units to become larger, and in accordance with the law of evolution, more highly specialized and complex in their internal arrangements.

# REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

## NAVAL ENGINEERING IN AMERICA.

### VITAL FEATURES IN THE DEVELOPMENT OF MODERN NAVAL POWER FROM AN ENGINEERING STANDPOINT.

*Report of Rear Admiral Melville.*

ONE of the most interesting features about naval development in the United States is found in the system whereby the heads of the various bureaus embody the results of their work with their recommendations and opinions in reports which are printed and freely given to the public. There is probably no other government in the world which permits such publicity in its workings as the Navy Department of the United States, and so far as the practical working of the system is concerned, this freedom of utterance is to the manifest benefit of the service.

Among the various interesting subjects treated in the report of Rear Admiral Melville, the Engineer-in-Chief, we notice especially the recommendations for an experimental engineering laboratory in connection with the Naval Academy at Annapolis. This is a matter which has been urged for several years past, and it is to be hoped that it will receive successful consideration at the hands of the coming Congress.

In urging the establishment of such a laboratory upon the Department, Admiral Melville says:

"Any naval service which is not kept in a state of efficiency has no reason for its existence. It is therefore the desire of naval officers as well as of the administrative officials of the Department to keep the ships ready for immediate service, and this can only be done by anticipating and providing for casualties and deterioration. The material that is now used in the construction of engines and boilers is of very high order. As in the case of a thoroughbred animal, its nature and qualities must be thoroughly understood, otherwise there is rapid decline. Desultory study upon the part of individuals is of course desirable, but systematic research and experiment can only bring about the best means of procuring good material and appliances and maintaining them in the highest possible state of efficiency."

In further emphasis of the importance of the question he enumerates several problems upon which reliable experimental information is needed, and which such a laboratory could supply, namely:

(a) The best means of utilizing liquid fuel for naval and maritime purposes. The naval power that can successfully install a liquid-fuel plant in a war ship will possess a great military advantage. It is not at all improbable that the liquid-fuel problem will have a very important effect in determining which nation shall possess the carrying trade of the world.

(b) The value of the steam turbine for naval purposes. The British Admiralty regard this subject of vital importance, and the success achieved with the torpedo-boat destroyers and with several merchant ships installed with this appliance warrant increased attention being given this matter. While it is true that the two torpedo boats of this type which were built for the British navy were short lived, the boats came to grief through no fault of the machinery.

(c) The best form and size of propellers; their location with reference to the keel and sternpost; the character and area of the blades. The experience of the various torpedo-boat builders during the past five years conclusively shows the necessity of extended investigation of this subject. The tests made by the Bureau twenty-five years ago in regard to propellers are still regarded as valuable, and urgent requests have been made that more experiments of this nature be conducted.

(d) The value of electricity as a prime mover for naval purposes. In the United States Navy the use of electricity is more extended than in that of any other service. Its endurance for naval purposes has been seriously questioned by others. Systematic tests and experiments would undoubtedly afford valuable information upon disputed points. It is pertinent to state that, while electricity has been used for operating winches, ammunition hoists, fan blowers, and other appliances, the steam capstan in the bow and the steering engine in the stern have still long lines of steam piping leading to these appliances. It is also somewhat paradoxical that the ice machine is still operated by steam, so that we have the anomaly of the cooling tank of this appliance condensing the steam and the steam in turn melting the ice produced. Illustrations of this kind show that considerable more study can yet be given the question of installing electric motors on board ship.

(e) The corrosion of boiler and condenser tubes. The rapid deterioration of boiler and condenser tubes, as already stated, seriously decreases the engineering efficiency of the modern war ship. The Bureau has made some important tests in connection with this matter, but the necessity for further investigation and experiment is exceedingly apparent.

(f) The best form and type of water-tube boilers for naval purposes. There are military and technical reasons why our navy should soon settle upon an approved type of boiler, and this design should, if possible, be one which is a development of a type used extensively on shore. There are so many factors that will interfere with boiler efficiency that extended experiments are necessary to secure reliable information upon the subject. In the investigation of this question a large appropriation could be profitably expended. During the past three years the British navy has expended hundreds of thousands of dollars in conducting comparative tests of different forms of boilers. While our navy has received valuable information from this source, it is exceedingly probable that information has been secured by the Admiralty which has not been given to the world at large.

(g) The possible advantages resulting from more extensive use of compressed air as a motor. Particularly at navy yards, and even upon repairs to ships in commission, a more general use of compressed air could be advantageously employed. Now that the water-tube boiler is coming into more general use in all navies, it is exceedingly probable that it will be necessary to use compressed air for properly cleaning these steam generators.

(h) The balancing of marine engines. There is a progressive tendency to increased piston speed, and with each succeeding year the necessity for more perfect balancing becomes necessary.

(i) The development of the storage battery for marine purposes. The discovery of a storage battery of decreased weight, but of increased endurance, will greatly add to the efficiency of the modern war ship. The fact should be conclusively established whether or not the gases generated can accumulate and produce explosions that will seriously injure the ship or impair important mechanical appliances.

(k) The perfection of a more reliable and efficient gas engine. The danger attending the use of this motor now makes it inadvisable for extended use in the navy.

(1) Extended investigation as to the best forms of steam, hydraulic, and pneumatic joints. By reason of the development of the water-tube boiler and the tendency toward increased steam pressure there has been considerable trouble experienced in keeping the joints tight. The delay and annoyance from such impairment may result in engineering inefficiency.

In spite of the limited opportunity available for experiments under existing circumstances the Bureau has been able to make some very interesting experiments upon oil fuel for marine boilers.

These tests have been made not only upon the steamship Mariposa, in the course of a run from San Francisco to Tahiti and return, and also upon an experimental water-tube boiler at Washington, and the results are of the utmost value to the engineering profession at large. In fact the report of the liquid-fuel board is itself an excellent example of the wisdom of the publicity which has been given to its work. Thus we read the following in the report of the board:

"The board is of the opinion that the best interests of the Navy will be subserved by making public at this time the data and information collected during fourteen official experiments that have been conducted. There are many persons outside of the naval service who are interested in the subject, and who would cheerfully render assistance along special lines if they could secure a knowledge of the general purpose and work of the board. These engineering experts in the mercantile marine, as well as in civil life, will in return obtain trustworthy information from the data secured, and thus be able to make important deductions. The benefit of submitting a preliminary report will thus redound to the material advantage of all interested in the development of the use of liquid fuel whether or not they are connected with the naval service."

We have space here only for the conclusions thus far reached by the board, but recommend all interested to study the details in the report.

"The following information has undoubtedly been secured:

(a) That oil can be burned in a very uniform manner.

(b) That the evaporative efficiency of nearly every kind of oil per pound of combustible is probably the same. While the crude oil may be rich in hydrocarbons, it also contains sulphur, so that, after refining, the distilled oil has probably the same calorific value as the crude product.

(c) That a marine steam generator can be forced to even as high a degree with oil as with coal.

(d) That up to the present time no ill effects have been shown upon the boiler.

(e) That the firemen are disposed to favor oil, and therefore no impediment will be met in this respect.

(f) That the air requisite for combustion should be heated if possible before entering the furnace. Such action undoubtedly assists the gasification of the oil product.

(g) That the oil should be heated so that it could be atomized more readily.

(h) That when using steam higher pressures are undoubtedly more advantageous than lower pressures for atomizing the oil.

(i) That under heavy forced-draft conditions, and particularly when steam is used, the board has not yet found it possible to prevent smoke from issuing from the stack, although all connected with the tests made special efforts to secure complete combustion. Particularly for naval purposes is it desirable that the smoke nuisance be eradicated in order that the presence of a war ship might not be detected from this cause. As there has been a tendency of late years to force the boilers of industrial plants, the inability to prevent the smoke nuisance under forced-draft conditions may have an important influence upon the increased use of liquid fuel.

(j) That the consumption of liquid fuel can not probably be forced to as great an extent with steam as the atomizing agent as when compressed air is used for this purpose. This is probably due to the fact that the air used for atomizing purposes, after entering the furnace, supplies oxygen for the combustible, while in the case of steam the rarefied vapor simply displaces air that is needed to complete combustion.

(k) That the efficiency of oil fuel plants will be greatly dependent upon the general character of the installation of auxiliaries and fittings, and therefore the work should only be intrusted to those who have given careful study to the matter, and who have had extended experience in burning the crude product. The form of the burner will play a very small part in increasing the use of crude petroleum. The method and character of the installation will count for much, but where burners are simple in design and are constructed in accordance with scientific principles there will be very little difference in their efficiency. Consumers should principally look out that they do not purchase appliances that have been untried and have been designed by persons who have had but limited experience in operating oil devices."

The question of the personnel bill and its influence on the future of the naval service forms an important feature in the report, and comment upon it will be found elsewhere in this issue.

# THE DIFFICULTIES OF ENGINEERING STUDENTS.

### TECHNICAL TRAINING FROM THE VIEWPOINT OF A STUDENT OF ELECTRICAL ENGINEERING—PRACTICAL VALUE OF THEORETICAL INFORMATION.

*Correspondence in the Electrical Review.*

WE have given much space of late in these columns to the important subject of technical education, believing that it rightly lies at the foundation of manufacturing and commercial supremacy. The discussions which we have reviewed, however, have all been papers of professional instructors and scientific men, of teachers; thus dealing really with but one side of the question. For this reason it is most interesting to note a communication in the *Electrical Review* from a student of electrical engineering, evidently anxious to acquire knowledge which will serve him in the subsequent practice of his profession, and encountering many difficulties by the way.

Taking the author of the article noted at his own definition, "an average, hardworking, industrious student, who is trying his very best to get on with the brains at his disposal," we find his principal difficulties may be summed up very definitely. In the first place he meets the usual query of students in nearly every line of work, a doubt as to the practical value of much that he is obliged to study. In this he notes the difference between the study of engineering and of medicine, the embryo physician realising at once that all he learns he will subsequently need to know. There is not so much in this objection, however, as at first appears, since the analogy between the two professions does not hold very far. In nearly every case the doctor practices his profession alone, that is, he visits the patients himself, performs the operations with his own hands, unless assistance is absolutely necessary, in fact, the higher he rises in his profession the more important does his own personal manual skill become. With the engineer the development leads rather to the relinquishment of detailed work to other hands, so that while he may commence with the making of drawings and the execution of shop work, he must expect, if he is to attain any measure of professional success, to delegate this work to subordinates, and to devote himself ultimately to just those departments of his profession which involve the things which appeared so unnecessary to him in his student days. He may rarely, if ever use the calculus in his personal work, using either the fully tabulated work of previous investigators, or possibly relegating all such work to a "tame mathematician" in a back office, but unless he has learned how to think with the logic of mathematical conceptions he will find it impossible to grasp the ideas which his growing work involves.

Again the student fails to see the combination between theory and practice, and his failure to grasp this relation naturally leads him to think that the trouble lies with his teachers and their methods, rather than with himself. Sometimes it does lie with the teacher, and often, far too often, the professor has never had the practical experience at all, having developed from the class room, through the stages of assistant and instructor, to the heights from which he attempts to impart knowledge of that practice which he knows but at second hand, or even further removed. At the same time the student must remember that he begins his practical training as he is completing his theoretical instruction, and hence the higher stages of the latter meet the elementary beginnings of the former, so that there is small wonder that the direct connection is not readily perceived.

It is altogether true that the relation between theory and practice is not readily acquired in the shop, since the shop workmen as a rule know nothing of the reasons involved in the work which they are doing, while at the same time they may be very well acquainted with the proximate causes of the effects under their immediate observation. At the same time the student who knows the theory of the shop operations, while he may not be able to connect the relations at once, will gradually find that there is a close relation, and having found this out he will make a progress far exceeding in rate that which he could have made without a correct understanding of the theory. That he should have to work some of these things out for himself, may well be laid to the limited time available for instruction, but it can surely not be made a reason for curtailing the study of theory.

In one feature the student's commentary on courses of training is most timely, namely, in regard to the desirability of providing some instruction upon the important subjects of works management and the commercial side of the profession. A short and practical insight into the very necessary commercial branch of his profession should certainly be given to the engineering student, since experience has shown that it is in this very department that existing manufacturing establishments are most deficient. At least the student should know the essential principles which constitute efficiency in manufacture and works management, a little about some system of standardisation in manufacture, so as to enable a large number of machines of the same class to be manufactured cheaply and quickly, a little about the law governing the relations between the employer and his workmen, and also a few gleanings from the patent laws, so as to be able to protect himself in any eventuality.

This whole paper is interesting, quite as much for what it fails to say as for what it sets forth. There is no doubt that modern educational institutions have many deficiencies, and that these are mainly in the field of fitting the student for his immediate practical work. At the same time it must be understood that the student himself has but vague ideas as to what his practical work really will be. It is far more important for him to be so thoroughly grounded in fundamental principles that the error in any fallacy shall strike him promptly and forcibly than that he should be able to set a lathe tool or wind an armature. It is even more important that he should be able to gather some isolated facts and state them in the form of a concrete question than to be able to solve that question after it is stated. He can find many ways of solving problems after he has got them clearly and logically placed before him; many students who can solve book problems most glibly never succeed in stating any practical questions whatever thereafter.

It is most definitely understood that nearly all progress in any branch of industry has been made by the intrusion of rank outsiders, men who have not gotten so deep into the ruts of practice that they cannot look over the sides of the cañons in which they so contentedly travel, and our dissatisfied student may well be thankful that he is given a chance to approach his work freed from the trammels of old established practice, while at the same time equipped with an unchangeable foundation of sound theory.

All these evidences of unrest in matters educational are most encouraging, and when we see professors and students alike discussing educational problems on their merits we cannot but feel cheered in the conviction that the doom of mediæval scholasticism is approaching and that the spirit of honest searching after truth is yet alive.

## THE STORAGE OF CONDENSING WATER.

### REGULATION OF CONDENSING WATER SUPPLY TO CONFORM TO THE FLUCTUATING REQUIREMENTS OF WIDELY VARYING ENGINE LOADS.

*F. J. Weiss—Verein Deutscher Ingenieure.*

MODERN steam engineering has so fully realised the importance and value of the condensation of exhaust steam that nearly every large power plant is placed where it can secure a supply of condensing water. Where such a supply is ample no especial provision need be made other than proper pump capacity. In most instances, however, the supply of condensing water must be handled with care, and even where great economy of water is not necessary, the regulation of the amount should be made to conform to the demand.

The general use of various forms of ejector and gravity condensers, in which the maintenance of an unbroken flow is important renders this question one which the engineer should be prepared to handle, and hence the exhaustive paper by Herr F. J. Weiss, in recent issues of the *Zeit-*

*schrift des Vereines Deutscher Ingenieure,* upon accumulators for condensing water, is of present interest.

The method adopted by Herr Weiss is an ingenious one, forming, as it does, a sort of hydraulic fly wheel by furnishing an intermediate reservoir of condensing water and regulating the flow according to the demand. The arrangement varies according to the form of condenser but in general it consists of a water tank, so placed that a portion of the water is intercepted on its way to the discharge, and returned to the condenser to be used a second time. By providing a tank of sufficient size there will be enough water stored to meet any sudden demand, while when the demand is lessened the stored supply will not be drawn upon, but will cool and be held ready for service.

Herr Weiss examines the theory of this system of stored water for gravity condensers at length, taking into account the heat stored in the water during the periods of heavy loads on the engine, showing that with such a storage tank the average supply may be maintained without risk of impairing the vacuum at any time. It is therefore rendered possible to use the minimum supply of water and at the same time be sure of a good vacuum, an important feature both from the standpoint of pumping economy and limited water supply.

In this connection we may call attention to the extent to which condensation is used in modern power plants. The old idea, in the United States especially, was that condensation was only advisable in the case of large engines, operating under fairly uniform loads, this following closely upon the pumping engine practice of Great Britain. The burden of air pump and cold water supply was thought to form too large a proportion of the total load for small engines to render condensation advisable, and high pressure was the rule. Within comparatively recent times, however, the idea of the central condensing plant has been introduced, this involving the maintenance of a single condensing and air pump system for all the steam machinery in an establishment. There is then a combination of a positive pressure system, the boiler plant, and a negative pressure system, the central condenser plant, the cylinders of all the engines, pumps, and other steam motors standing between them. This arrangement is an ideal one for the large power plant containing as it does engines, pumps, and steam machinery of all sizes and kinds. However variable the load may be upon the various engines, the exhaust discharge of all of them will be close to the average, so that a uniform water supply and a constant speed of air pump will serve to maintain a fairly constant vacuum economically.

The importance of a good vacuum is especially to be considered for the small engines in a plant, which are necessarily of low economy in any case, and consume a large proportion of the total amount of steam generated. On shipboard the low economy of the auxiliaries has been partially compensated by allowing them to exhaust into the receiver space, their cylinders thus acting as high-pressure cylinders in a compound system of which the low pressure cylinder of the main engine forms the continuation.

# THE SPONTANEOUS COMBUSTION OF COAL.

## NATURE, CAUSES, AND METHODS OF PREVENTION OF SPONTANEOUS COMBUSTION OF BITUMINOUS COAL.

### *Recent Experiences in France.*

ONE of the difficulties which has always been encountered in the handling and storage of soft coal has been the liability to spontaneous combustion. In the mine this has been a not infrequent source of mine fires, while on shipboard it is always a cause for anxiety to engineer and captain, and the same question must be met when large quantities of bituminous coal are stored in the yard, on the dock, or elsewhere.

The valuable paper of Commander Caborne upon this subject was reviewed at length in these columns last February, and now we have the important series of papers by M. J. Abadie, in recent issues of *Le Génie Civil,* discussing in general the causes of fires in mines, and giving some valuable results of experiences with spontaneous combustion in the mines of the Decazeville district, in the Department of Aveyron, in the south of France.

In view of the fact that by far the greater portion of all the coal available for use is of the bituminous variety, and that it must naturally displace anthracite before many years, it is most important that the causes and methods of prevention of spontaneous combustion be fully understood, and hence we abstract that portion of M. Abadie's paper which treats of the subject.

Broadly speaking, the fundamental cause of spontaneous combustion is oxidation, and it is therefore originally due to the admission of air to the interior of the mass. In the mine this may take place by reason of the breaking down of portions of the seam, crushing the coal and permitting the infiltration of air, but in the case of mined coal the admission of air is a matter which may be more effectively controlled.

In order that the oxidation may proceed rapidly enough to generate heat sufficient to ignite the coal, there must be an ample supply of air and free opportunity for contact. On the other hand if the circulation of air throughout the mass be sufficiently high it will act to carry away the heat and thus cool the coal, so that in many instances the oxidation will not cause the temperature to rise to the igniting point. It is this fact doubtless, which has caused so many contradictory statements to appear as to the effect of ventilation upon spontaneous combustion.

The presence of pyrites was formerly considered to be the principal element in the spontaneous combustion of coal, but this is now known not to be the case, although it is doubtless true that the presence of a quantity of iron pyrites in the presence of air and moisture may aid in the generation of heat. This question of the presence of moisture is especially important when pyrites are present, but otherwise it does not appear to influence the heating of the coal.

A very important element in the furtherance of spontaneous combustion of coal is the temperature of the surrounding air. It is now well understood that a very moderate increase in the temperature of surrounding bodies is sufficient to increase very greatly the rate of oxidation and thus to promote the further rise in temperature of the coal to the ignition point.

Thus in mines the heat of underground workings, and especially the approach to older burning measures, may suffice to produce spontaneous combustion when it had previously not been anticipated.

The same is true on shipboard, and the greatest care should be taken to prevent the running of lines of steam pipes close to the coal bunkers, and to avoid the arrangement of coal storage close to the shells of the boilers.

Since spontaneous combustion of bituminous coal, therefore, is due to oxidation, the first precaution to be taken is to prevent access of air to the mass. This can generally be effected more or less completely on shipboard, or in mines, and hence its importance should be appreciated. The avoidance of external heat should also be considered, and it is probable that this has not received proper consideration on shipboard, where too often the pipes are run without due regard to the effect upon the surroundings.

The influence of the introduction of air into the mass of coal has been clearly shown by the experiments of M. Fayol. Thus a cask of bituminous coal was so arranged that a thermometer, with its bulb placed in the centre of the mass, could have the temperature read upon its projecting stem. The cask was arranged with numerous holes above and below so that the admission and circulation of air through the mass could be regulated at will. Numerous experiments with this simple apparatus showed that with the admission of air the temperature rose until a maximum was reached, after which further admission of air caused the temperature to fall. This clearly proved that there is a point beyond which the air carries off the heat faster than it can be generated. At the same time the practical impossibility of insuring such a complete ventilation throughout the entire mass of the coal renders it impracticable to use this idea for keeping the coal cool, since any point insufficiently ventilated might reach the ignition temperature, and thus set fire to the whole mass.

The methods to be followed to extinguish a fire in the body of a mass of coal naturally differ somewhat from those for ordinary fires. All access of air should be cut off as completely as possible, and where this can be effectively done the exhaustion of the supply of oxygen must soon follow. The heat remaining in the mass however, will cause immediate ignition upon opening the compartment, hence ample time must be allowed for cooling. On shipboard it is wise to provide some special apparatus for fighting fire in the bunkers, the most effective forms being those which operate by the forcing of some suitable gas into the burning mass. Usually carbonic acid gas is used for this purpose, but Commander Caborne advises the employment of sulphur dioxide, readily produced by burning sulphur in the open air, and delivering it into the bunkers by a blower.

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# THE SPEED OF ARMORED CRUISERS.

### A DISCUSSION OF THE POWERING AND ARMOR-PROTECTION OF THE AMERICAN CRUISERS TENNESSEE AND WASHINGTON.

*Reports of the Board on Construction.*

MUCH interest has been exhibited in engineering circles in the discussion regarding the disposition of the weights in the new cruisers authorized by Congress, and known officially as Nos. 10 and 11, to be named when completed, "Tennessee" and "Washington."

The Board on Construction, to which the details of the new vessels are intrusted, consists of the Chiefs of the Bureaus of Ordnance, of Steam Engineering, of Construction and Repair, and of Equipment, together with the Chief Intelligence Officer. The question upon which the discussion has taken place in this board may best be understood by reference to the majority and minority reports, the latter having been made by the Engineer-in-Chief, Rear Admiral George W. Melville, U. S. N., Chief of the Bureau of Steam Engineering, which Bureau has in charge the design and construction of the engines and propelling machinery.

The cruisers under construction were limited by Congress to a "trial displacement" of 14,500 tons, but upon the presentation of the plans for the vessels and their machinery to the board by the various bureaus it appeared that the total of the weights exceeded this amount by 70 to 80 tons. At the same time it was proposed by the board to increase the weight of armor, so that the total excess reached nearly 200 tons.

Two methods were proposed to reduce this excess in weight, one being to diminish the thickness of armor and weight of armament, and the other to reduce the power of the engines. In the majority report, signed by all the members of the board except Admiral Melville, it is stated that 190 tons, the amount to be saved, represents 35.7 per cent. of the total weight of the battery, and 7.2 per cent. of the total armor protection. If this same amount is taken from the weight of the machinery it would require the power to be diminished from 25,000 to 23,000 horse power.

It is maintained by Admiral Melville that such a reduction in powering will reduce the speed from 21.5 knots to 20.9 knots, this being based upon the fact that the total displacement when the ship is in commission and ready for sea will be more than 16,000 tons.

The majority report, considering only the trial displacement of 14,500 tons, maintains that a speed of 22 knots can be secured with 23,000 horse power, this opinion being based upon experiments made in the model testing tank at the Washington Navy Yard, but Admiral Melville calls attention to the fact that trials upon small models cannot be depended upon to such a close margin, he preferring to be governed by the actual performances of vessels already constructed and possessing the same size and fineness.

As to the importance of speed in armored cruisers, Admiral Melville makes some very pertinent remarks, and in view of the fact that Congress stipulated that the proposed vessels should have the "highest practicable speed" we may quote from his minority report: "I cannot believe that Congress did not intend that these vessels should be equal to or superior to any of their class, that class being armored cruisers, and not battleships where very high speed may not be so essential; and I am not at all certain that an extra knot and the additional power for it should not have been insisted on in the first place."

In considering the class to which the proposed cruisers belong comparison is made with the "Drake" class in the British navy. These vessels are 500 feet in length; 71 feet beam, and draw 26 feet at a displacement of 14,100 tons; in other words they are 2 feet shorter, 1 foot 10½ inches less beam, 1 foot more draught, and 400 tons less displacement than the "Tennessee" class. On the other hand they are of 23 knots speed, and are given 30,000 horse power, or a full knot more speed and 5,000 more horse power than was even proposed for the "Tennessee," and so can engage with or avoid the latter ship at will. The protection of the "Tennessee" is claimed to be much better distributed than that of the "Drake," and her main battery is much heavier, but this is to a great extent offset by her great inferiority in speed, which places her at the very great disadvantage of not being able to use it unless the faster vessel permits it.

Admiral Melville frankly states that he does not believe that 23,000 horse power will give the vessels of the "Tennessee" class a speed of 22 knots, and this belief is based on the performance of similar ships. The "Drake" class are of 400 tons less displacement and have finer lines, and it required about 23,000 horse power to give them a speed of 22 knots on their trials. The "Gambetta" class, in the French navy, is to have 27,500 horse power to make 22 knots on 12,416 knots displacement. From this it would appear that 25,000 horse power is a very moderate estimate of the power required to drive a ship of 14,500 tons displacement 22 knots, and an armored cruiser of that size that cannot make it cannot be considered an up-to-date, first-class ship.

Although Admiral Melville is in the minority, so far as the board is concerned, there is little doubt that his views are sustained by the great majority of engineers who are qualified to judge in the matter. The question of speed is a vital one for a cruiser, and any increase in armament at the expense of speed simply results in transferring the vessel to another class. If battleships are desired that fact should be considered from the first, but if cruisers are intended it is cruisers which should be built. Especially is it important that the full displacement of the vessel when in commission should be taken into account in the powering. Trial displacements are as fictitious as trial speeds, and neither play any real part when the cruiser is in action or in service. The behaviour of the Oregon in the chase at Santiago brought out most emphatically the surprise of all at the fact that a vessel should ever after equal her trial speed, and it seems altogether senseless to specify a speed under conditions which can never afterwards be reproduced. It is to be hoped that trial speeds may some day be relegated to the limbo to which "nominal" horse power has long since gone, and that men who, like engineers, are accustomed to precison in all other forms of measurement, may treat the speed of a ship with the same degree of accuracy as they do many other things of infinitely less importance.

# ELECTRIC RESPONSE.

## A STUDY OF THE PERCEPTION OF SENSATIONS IN VARIOUS FORMS OF ORGANIC AND INORGANIC MATTER.

*Prof. Chunder Bose, before the British Association.*

THE excellent work which has been done during several years past by Professor Jagadis Chunder Bose, in connection with the production and reception of electric waves is well known. The results of a portion of his researches were presented to the Royal Society last summer, and following these communications comes a most interesting demonstration before the British Association at its recent meeting at Belfast.

Broadly, the work which Professor Bose has undertaken is to show the relation between molecular and electrical disturbances. It is well known that when a body is subjected to mechanical stress there is a corresponding mechanical strain produced. Professor Bose shows that this is also accompanied with some form of electrical disturbance.

Apart from the interest which these experiments have aroused in scientific circles, they have also attracted a popular curiosity in that they tend to show that all substances, organic and inorganic, possess some degree of sensibility, thus suggesting a continuous connection between the organic and inorganic world.

The details of some of Professor Bose's experiments form very interesting reading, but a full conception of their meaning can be obtained only by a careful study of his published papers.

We may, however, give a general idea of the apparatus employed, together with a brief account of some of the results.

The simplest form of apparatus consists of a metal rod, of which two points are connected with a galvanometer by means of non-polarisable electrodes. If this bar is struck between the connections to the galvanometer, there will be produced a wave of molecular disturbance. If any electrical disturbance is also produced, it cannot be shown under these circumstances, since the wave will be sent out through each electrode, and they will balance each other and produce no effect upon the galvanometer needle. If, however, some means can be found of checking, or otherwise affecting the wave in one or the other direction, this balance will no longer exist, the galvanometer will be affected, and the difference between the two waves will appear.

Two methods have been found for producing intelligible results. One of these is called the method of "block," and may be considered as a mechanical operation. Thus, if a clamp be placed upon the wire, between the point struck and one of the electrodes the wave will be hindered from reaching one electrode, and a momentary swing will appear upon the needle. By using a mirror galvanometer and receiving the moving spot of light upon a travelling band of sensitised paper, the actions will be recorded as curves.

The second method employs chemical action to deaden or exalt the sensibility of one portion of the rod or wire. Thus if a portion of the rod be moistened with distilled water, or with dilute solutions of sodium chloride, potassium bichromate, etc., no effect is produced, while some reagents enhance the electrical excitability, and others again, depress it. Thus when one portion of the rod is moistened with sodium carbonate, that portion will be found more excitable than before, and a stimulus given to the rod will affect the moistened end to a greater degree than the other portion, and a corresponding deflection of the galvanometer will appear. If, however, a solution of oxalic acid is used, a depressing action will be observed, the current flowing in the opposite direction upon the application of stimulus.

Professor Bose gives a number of experiments showing interesting variations upon these lines, all tending to show that mechanical disturbances are accompanied by corresponding electric waves, and that this action can be modified by stimulating or deadening substances in a very definite manner. In other words materials which are undoubtedly inorganic, and in the common parlance altogether "dead," are capable of responding to external stimulus, and thus possess, to a certain extent, perceptions of sensation similar to those of living matter.

In order further to study the analogy between this electric response in inorganic matter, and the perceptions of living things, Professor Bose has conducted a series of experiments showing precisely similar actions in living tissues. The effect of stimulus upon motile tissues, it is true, causes a change of form, but upon the nerves, for example, no change of form follows, although a distinct response is produced. The excitation of the tissue may, however, be detected by a certain electromotive change, and in this respect the behaviour of nerve tissue is similar to that of the inorganic rod already discussed.

Electric response is a measure of the physiological activity of the tissue. When the physiological activity is exalted by a stimulant, the electrical response will rise in amplitude. When the activity is diminished, as by narcotics, the electrical response is also diminished, and when the tissue is killed the electrical response disappears altogether. Ordinarily these response phenomena have been regarded as due to some super-physical "vital" force, but this conclusion is not justified, since the response processes seen in life correspond closely to those foreshadowed in non-life.

On account of the wideness of the gap between animal and metal, Professor Bose undertook experiments upon the intermediate world of plant life. The analogy was shown to be remarkably close. Response was obtained in all plants and by all their organs. When the plant was killed by poison or by hot water the electrical response disappeared. The responses in plants and in metals were shown to be modified exactly in the same way as animal tissues are modified, there being not a single phenomenon in the response in muscle and nerve that has not an exact parallel in the response of metal and plant. Just as the response of animal tissues is found to be exalted by stimulants, lowered by depressors, and abolished by poisons, so also it is found that under the action of appropriate reagents the response in plants and metals undergoes similar exaltation, depression, or abolition.

The conclusion reached by Professor Bose, therefore, is that: "Irritability or capacity for response is not confined to living tissues. The living response in all its diverse manifestations is but a repetition of the physical phenomena exhibited by the inorganic. There is in it no element of mystery or caprice, as is admitted on the assumption of a hypermechanical 'vital' force, acting in contradiction or defiance of those physical laws which govern the world of matter. Nowhere in the entire range of these response phenomena—inclusive as that is of animals, plants, and metals—is there any breach of continuity. The response phenomena are not determined by the play of an unknowable and arbitrary vital force, but by the working of laws that know no change, acting equally and uniformly throughout the organic and inorganic worlds."

# SMOKELESS COMBUSTION OF BITUMINOUS COAL.

SCIENTIFIC CONSTRUCTION OF FURNACES AND CORRECT CONDITIONS OF COMBUSTION.
BRITISH AND AMERICAN EXPERIENCES.

*An International Symposium.*

EVER since the introduction of steam power attempts have been made to provide for the smokeless combustion of coal, and while the problem has been studied by able engineers from the time of Watt to the present, there is little doubt that the smoke question is daily becoming more pressing. In England, where all the coal used both for industrial and household purposes is entirely or partially bituminous, the subject has long been a matter for consideration, and the same has been true of Pittsburg and other cities in the United States in which soft coal is used. Until recently, however, a number of the large cities on the Atlantic coast of the United States have been free from the annoyances and discomforts of soft coal smoke and it is only by reason of the prolonged labor troubles in the anthracite coal districts of Pennsylyania that the use of bituminous coal in New York, Philadelphia, and other cities has called attention to the fact that the supply of anthracite must be considered as limited and irregular, and that the sooner the smokeless combustion of bituminous coal becomes the rule, the sooner the dominating power of a limited territory under the control of a few people, over the comfort and purse of the public will be terminated.

The supply of bituminous coal in the United States at least, and in Asia, is practically unlimited, and when it is properly burned it offers no difficulties or inconveniences, while at the same time its excellent calorific power renders it entirely satisfactory so far as steaming is concerned.

Among recent articles on the subject of the smokeless combustion of bituminous coal we note the excellent paper of Mr. W. H. Booth, presented at the Belfast meeting of the British Association, the exhaustive series of papers by Mr. Albert A. Cary, in late issues of the *Iron Age,* the communication of Mr. T. T. Parker, in the *American Machinist,* and various other articles, all bearing upon features of the problem.

These papers, while differing in their treatment of the subject, all agree in emphasising the one fact that the usual appliances for burning bituminous coal in practice are constructed with entire disregard of the true principles of combustion.

Thus Mr. Booth says: "Engineers are taught at college that combustion can only take place in the presence of a sufficient supply of oxygen at a sufficiently high temperature. An ordinary class-room experiment is to surround a candle flame with a coil of wire, which abstracts heat so rapidly from the flame as to cause combustion to cease, and the flame is extinguished. This experiment contains the whole secret of combustion. When engineers go out into the world, they find that the burning of coal and generation of steam are carried out upon lines which are quite opposed to the principles they were taught at college, and more upon the lines of the refrigerated candle-flame experiment. They become aware that the daily practice of steam raising, while opposed to theory, is very far from good, and they are told that it is not possible to burn bituminous fuel except with evolution of smoke. Most engineers acquiesce in this very lamentable state of affairs, and are the more inclined to do so, because, where teachers of engineering have been responsible for boiler arrangements, they are unable to find that these present any differences from the common herd. The modern steam boiler is, in fact, quite as primitive as a common pan set directly upon a fire to boil. An African savage, with a gourd as his pot, places this to boil just as scientifically as do our professors of engineering place boilers. The modern boiler maker merely sells boilers. The consulting engineer, who ought to order their setting, accepts the methods of the savage, the impossibility of which, in respect of good results, he has taught, or has been taught at college, but has not comprehended."

Mr. Cary fully agrees with this position, saying:

"The smoke nuisance from boilers can be almost entirely avoided by the adoption of proper furnaces adapted to the fuel used and by the employment of a sufficient amount of intelligence to handle the fires properly. The whole secret of burning fuel smokelessly is to obtain complete combustion in the furnace and combustion chambers before any appreciable amount of the combustible gases meets the chilling water surfaces of the boiler."

While indeed there are certain fuels which show smokeless combustion, such as charcoal, coke, and anthracite, these too demand proper conditions in order that the full thermal efficiency may be obtained from them, so that the whole question of the proper combustion of fuel for steam making can be reduced to certain fundamental principles.

Although these principles have been known for a long time, and their demonstration is included in every elementary course in physics, we see them almost totally ignored in engineering practice. In locomotives we find the combustion carried on in a contracted box in which five of the six walls are formed with water spaces, usually miscalled heating surface, but more properly entitled cooling surface. In the type of marine boiler in general use the fires are maintained in small cylindrical furnaces, than which nothing more effective for chilling the fire could well be devised. Water-tube boilers are nearly always set with the tubes directly over the fire, while the horizontal tubular boiler, so extensively used in the United States, is also set directly above the grate.

The immense influence which these constructions have upon the combustion of the coal will be seen when it is understood that the igniting temperature of bituminous coal is between 700 and 800 degrees F., while the temperature of the water in the boiler, and hence of the metallic surfaces close to the fire, is not more than one-half as much, and therefore complete combustion cannot be expected.

The idea of the practical man is that all this can be remedied by the admission of an excess of air, since he assumes that the presence of oxygen will suffice to make up for lack of temperature. In this he forgets that the finely divided particles of unburned carbon which constitute smoke cannot be so readily disposed of. The particles of carbon are really floating in an atmosphere of nitrogen and of carbonic acid, and in most cases the excess of air admitted never reaches the combustible at all, but serves only to dilute the whole, absorbing heat and passing out of the chimney unused.

The remedy for this state of affairs is obvious, so much so that many overlook it altogether. If the furnace be removed altogether from its close proximity to the cooling surfaces of the boiler, and be surrounded by walls capable of being raised to a temperature higher than the critical igniting point of the fuel, there will be no difficulty in burning all the combustible constituents of the fuel, provided sufficient oxygen be provided. In other words there should be a separate furnace of ample size constructed, conveniently placed in front of the boiler, and containing only the grate, and including walls of firebrick capable of being maintained at a high temperature. The throat of the furnace can communicate directly with the flues or other heating surface of the boiler, and the intensely hot products of the already completed combustion thus delivered where they will do the most good without the possibility of producing smoke.

Again the practical engineer interposes an objection. "We know," says he, "that the surfaces of the boiler exposed to the radiant heat from the fire constitute the most effective portion of the entire heating surface of the boiler; are these to be discarded?" As a matter of fact, we know nothing of the sort. We know that a large portion of the so-called heating surface is far inferior to the rest, but this is due to the fact that it is so placed that it receives only the partially consumed and already cooling portion of the fuel. The fuel contains a definite, and ascertainable number of heat units; when it is fully burned these heat units are released in the sensible form; and, if they do not escape through the walls of the furnace or up the chimney they must be absorbed by the boiler and utilized in the evaporation of water.

Furnaces of this kind are in continual and satisfactory use for the complete combustion of fuels which would be altogether worthless if fed upon the ordinary grate, such fuels as wet spent tan bark, bagasse from sugar mills, etc., and there is no earthly reason why methods entirely practical, and altogether theoretically correct, should not be used for bituminous coal, a fuel quite as unfit to be fed into a common furnace as any which could be named.

It has been said that much of the smoke in British cities comes from the chimneys of private residences, and that properly designed boiler furnaces would abate but a small portion of the evil. There is but one remedy to be offered for this portion of the problem, but it is one which should be promptly accepted. The only fuel fit for household purposes is gas. Fuel gas should be supplied to all houses in cities, and the use of solid fuel become as obsolete as that of flint and steel, tinder, and other ancient nuisances. There is no reason why any great city should be a victim of the smoke nuisance except that of the wilful perversity of its inhabitants, and those who are afflicted by the filth and unhealthfulness of an atmosphere laden with the products of incomplete combustion should receive no sympathy or commiseration from the more intelligent portions of the community.

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# ELECTRIC DRIVING OF MACHINERY.

LARGE ELECTRIC MOTORS IN THE ANTWERP ROLLING MILLS—GROUP AND INDEPENDENT MACHINE DRIVING IN GERMANY.

*La Revue Technique—Glasers Annalen.*

ELECTRIC driving of machinery is necessarily on the increase, and present interest is directed mainly towards its methods and its limitations. At first it was supposed that the electric motor was suited only for light machinery, such as small printing presses, laundry machinery, and the like; then, when it appeared that it was well adapted for machine tools of fair size, the question came up as to the economy of using separate motors for small tools, and the arrangement known as "group" driving came into vogue, one motor operating a short section of shafting, from which a number of tools were driven by belting. The driving of such heavy machinery as the rolls of the iron and steel mill, while often discussed, has only recently become a reality.

So far as heavy driving is concerned, the latest example is found in the new iron and steel works under construction at Hoboken, on the banks of the river Scheldt, near Antwerp. Curiously enough, these mills, the first in which direct electric driving has been employed for heavy rolls, are equipped with machinery sent from America, although such motors have as yet not been employed in this work in Pittsburg, the city of their origin. From an account in *La Revue Technique* we extract some description of these new mills, with especial reference to their power plant.

The works are planned on the most modern lines, there being six blast furnaces of 350 tons capacity each; the daily consumption being 4,200 metric tons of iron ore, 1,070 tons of flux, and 3,050 tons of coal. The coking furnaces, which form a part of the plant, are of the modern by-product type, while an auxiliary cement works is provided for the purpose of utilising the furnace slag.

Electric power is to be used in all departments of the work. The preliminary power plant, operated by steam, includes two 1,500 horse power generating sets; a three-phase current of 2,200 volts at a frequency of 50 cycles being generated. The completed plant is to generate 30,000 horse power, employing gas engines supplied with the waste gases of the blast furnaces, and all the power is to be electrically transmitted from the power house to the various parts of the mills. The most powerful single motors thus far installed are of 350 horse power, these being directly connected to the plate mills and belted to the blooming train. Electric cranes are provided throughout the works, and numerous small motors provide the power for the live rolls, shears, and all the multifarious power machinery of the establishment.

While it is too soon to give operative data concerning this modern installation of electric power, there is every reason to believe that it will be altogether successful, and by reason of its advantageous situation for the receipt of raw material and the shipment of product, it should prove an important commercial enterprise.

The question of the relative advantages of group and independent machine driving for tools of moderate size has been recently given careful study in the shops of the Vienna-Warsaw railway at Pruschkowo, and from an account by Herr von Reichel, in a recent issue of *Glasers Annalen* we give some of the results. The tests were conducted upon a set of four wheel-lathes, which had for some time been operated by independent motors of three horse power each, the supply being a three-phase current of 190 volts pressure. Careful tests, the details of which are given in Herr von Reichel's paper, show that for various speeds and feeds these lathes consumed from 0.88 to 2.40 horse power each.

In order to test the economy of group driving, the same lathes were then belted to a countershaft, which in turn was belted to a single motor, the belting being so arranged that any or all of the machines might be driven. The tabulated results are given in the article, and it appears that the loss of power in the transmission operated to render the group driving decidedly less economical than the use of independent motors for each lathe. This was the more apparent when only a portion of the machines were in operation, and as the general experience is that the full number of machines is rarely if ever in simultaneous operation, this fact must be taken into consideration. Without going into details, it appears that with all four machines in operation the independent system consumed but 69 per cent. of the power required for the group system.

The general conditions under which the machinery is operated naturally affects to some degree the relative economy of the two systems, and hence we give the general conclusions which Herr von Reichel appends to his paper, referring the interested reader to the full account for some very interesting details of an excellently conducted test.

Herr von Reichel finds that independent driving may be considered more advantageous than group driving when not more than 75 per cent. of the machinery is operated continuously during the entire working day; when, however, the operation covers continuously a greater portion of the time, group driving may be found of advantage. In the equipment of new shops and in the planning of new works for electric driving, independent driving should always be used, since the slightly greater first cost will soon be repaid by the greater economy in operation. In the equipment of old shops with electric driving both group and independent driving may be employed as convenience may indicate, but for machines which are situated at a distance from the motive power, independent driving will be found most advantageous.

It is especially desirable, in equipping a shop for electric driving, to purchase tools especially designed to be operated by electric motors. In case a number of tools in the same place are to be adapted to electric driving much power may be required which might otherwise be saved, had the tools been designed for the application of motors in the first place.

Apart from the direct economy involved in independent driving, it must be remembered that the advantageous placing of the machinery often effects as great a gain in space and operation as is saved in actual energy for driving, and in many instances the latter considerations become of controlling importance, economy of power being secondary.

## LIGHT TELEPHONY.

EXPERIMENTS WITH A SELENIUM PHOTOPHONE ON THE WANNSEE, NEAR BERLIN.
WIRELESS TELEPHONY WITH A BEAM OF LIGHT.

*Ernst Ruhmer in the Elektrotechnische Zeitschrift.*

IN the original photophone of Professor Bell, a beam of light was reflected from a diaphragm set in vibration by sound waves, and the undulating beam caused variations in the illumination of a selenium cell placed at a distance. As is well known, the electrical resistance of selenium becomes less with increasing illumination, and if a selenium cell be placed in circuit with a battery and a telephone, variations in the light falling on the selenium will cause variations in its resistance and changes in the current flowing in the circuit, and hence sounds in the telephone.

Modifications and improvements of the original apparatus have been made from time to time, but it has remained little more than a scientific curiosity until recently, when Herr Ernst Ruhmer took up the active development of "light telephony." He has attained a considerable degree of practical success in experiments made on the Wannsee, near Berlin, which he describes in the *Elektrotechnische Zeitschrift.*

Herr Ruhmer's sending apparatus consists of a parabolic searchlight reflector, with a carbon arc light at its focus, a microphone telephone transmitter in circuit with a battery, and an induction coil with one winding in the microphone circuit and the other in the arc lamp circuit. By this arrangement, the rapidly-alternating telephonic currents of the microphone circuit are superposed upon the continuous lighting current, thus causing variations in the intensity of the arc and consequently in the beam of light issuing from the reflector. It is necessary to supply the arc light with current from a primary or a storage battery, for the commutator of a dynamo would cause periodic vibrations in the arc, which would seriously interfere with telephonic transmission.

The parallel beam of light from the reflector, varying periodically with the microphone transmitter current, proceeds in a straight line to the receiving station, where it strikes another parabolic mirror and is reflected to the focus of the latter, at which is placed a selenium cell. The selenium is in circuit with a battery and two telephones, and as its resistance changes with the varying beam of light, the accompanying changes in the battery current produce sounds in the telephone receivers which correspond with the sounds uttered into the transmitting telephone at the sending station.

As Herr Ruhmer remarks, good transmission of speech by this method depends on the amplitude of the microphone current oscillations, on their proper superposition upon the continuous current of the lamp, on the strength of the lighting current, on the accuracy of the parabolic reflector and its proper mounting, on the clearness of the atmosphere, on the size of the receiving mirror, on the sensitiveness of the selenium cell, and finally, on the proper voltage of the battery and resistance of the telephones at the receiving station.

Perhaps the most essential feature of the whole system is the selenium cell. It is necessary that it should be sensitive not only to light in general, but particularly to those wave lengths whose amplitude is most widely varied by the transmitting apparatus. Now it has been found that it is the short light waves which are chiefly concerned in producing the "speaking" beam, and on the other hand, ordinary selenium responds most readily to those rays which are comprised between the red and the greenish-yellow parts of the spectrum. Herr Ruhmer has succeeded, however, in constructing selenium cells which are sensitive to all wave lengths of light, and which, moreover, when the illumination ceases, return to their original state with remarkable rapidity. His selenium cells are made with thin layers and are cylindrical in form, so that when placed at the focus of a parabolic mirror, they will be illuminated on all sides. The sensitive cylindrical surface is 23 millimeters long and 18 millimeters in diameter. When in the dark the resistance of such a cell is 120,000 ohms. With an illumination of 64 lux, the resistance falls to 9,100, and at about 20,000 lux,—corresponding to the illumination due to a sixteen-candle incandescent lamp close by, or that of the winter sun on a surface perpendicular to its rays—the resistance is only 1,500 ohms.

In the experiments conducted on the Wannsee, the transmitting apparatus was carried on an electric launch, equipped with an accumulator battery, and the receiving station was placed at different points on the shore, or on another boat. Successful transmission was attained at distances ranging up to 7 kilometers, in all kinds of weather from clear to rainy, and by day as well as by night. It is rather surprising to learn that operations succeeded in daylight, but it was found that when the receiving mirror was shielded from the direct rays of the sun, very good transmission was secured.

These results are an advance on anything of the kind that has been done before, and are highly gratifying, but their practical importance is somewhat diminished by the rapid progress of wireless telegraphy, whose range is so greatly in excess of that of the photophone, and which will most probably be adapted to the practical transmission of articulate speech before very long.

Light telephony can never work over greater distances than can a heliograph, and is subject to the other limitations of the latter, but within these limits it may well find a field of usefulness, particularly in military operations.

## AN INTERESTING ANNIVERSARY PUBLICATION.

### PAPERS BY THURSTON, MELVILLE, SWEET, BOOTH, AND OTHERS UPON THE ENGINEERING DEVELOPMENT OF A QUARTER CENTURY.

*American Machinist—Twenty-fifth Anniversary.*

OUR interesting contemporary, the *American Machinist,* having reached its twenty-fifth birthday, very properly celebrates that event by the issue of an anniversary number, and in it appears a number of articles by men who have been identified with the growth of mechanical engineering during that period. The limitations of space will not permit more than a passing glance at some of these contributions, but some quotations may serve to show how the development of the period looks to men who have not only seen it, but have in great measure been instrumental in bringing its changes to pass.

Thus, speaking of the progress of technical education, Professor Thurston says: "The literature of the mechanical and engineering departments of industry has come to be extensive and is constantly growing in quantity and quality at an accelerated rate. Its character has greatly changed and the most important problems of the mechanic, the constructor and the engineer are now capable of scientific and exact solution, and the sporadic production of improved devices and of "inventions" by the amateur genius is largely superseded by the deliberate and exact study of the problem of improvement by the designer, by his precise definition of the conditions to be met and by his scientific and accurate solution of his problems. The art of exact design, based upon scientific principles and experimentally determined, accurate data, is the modern expert's method of supersedure of the older ways of the amateur inventor."

Rear-Admiral Melville, among other interesting points which he makes concerning the work of the engineer in naval affairs, shows the close connection between industrial and military supremacy.

"The comparative strength of nations as regards sea power, as well as their relative position in dominating the affairs of the world, is directly proportionate to the output of their industrial establishments, since the relative measure of naval strength of different countries can better be determined by the number and character of the naval stations and ship-yards which they possess than by the vessels which are in the several navy lists. The engineer, whether afloat or ashore, has thus become a military as well as an industrial factor, and it will be the outcome of his work which will decide the battles of the future, whether fought on land or sea.

"Another important effect of the work of the engineer in military and naval development rests in the fact that all nations have been taught that in the future the art of war will be more dependent upon the principles of engineering than of military tactics. The strategy of the future will involve a knowledge of the possibilities of mechanical appliances, for hereafter the weather gage of the enemy will not be secured by the smart seaman, but by the skilful engineer. The movement of armies on land will not be dependent upon some stroke of military genius, but rather upon the reflective work of some engineer who has mastered the subject of transporting safely and expeditiously large bodies of men and supplies."

The mooted question of British and American machine tools is treated by Mr. W. H. Booth in by far the most sensible manner we have seen for a long time. Speaking of the fact that American tools, when transplanted to England, failed to give the output of work which they had shown in the land of their origin, he calls attention to the fact that the discrepancy might be due to other causes than the antagonism of the workmen. A portion of the difference at least, he considers to be due to the harder material used in Great Britain.

"American tools coming over here have become heavier, and when heavier tools began to come over we began to hear complaints that they would not do the work they were sold to do and they were worn out of truth in a few months. This rapid wear was urged as a reason for scrapping, but it is certain that ordinary machine tools are not so obsolete in a year's time as to require scrapping. The obsolete theory was somewhat overdone.

"I have gone carefully into this question of the hardness of cast iron, and, personally, I have no shadow of doubt that English cast iron is very much harder than anything that comes from outside. The wear that takes place in American tools manifests itself in two ways: First, it compares with the wear on our own hard irons; and, secondly, American tools made to cut American iron were too light and had surfaces too small when set to cut our hard iron. Then the attempt to run the tools at the speeds stated they would run was provocative of disaster. Failure was laid to British clumsiness on one side and to Yankee flimsiness on the other. Sober-minded men realized that the whole matter was one of materials."

There is no doubt that tools of American design, made on either side of the Atlantic, have become modified by the nature of the work which they have to do; and the result is the production of what was predicted in these columns several years ago, the international design of machine tools, in which the good points of the practice of all industrial nations are being combined, and the weak features of all eliminated.

Professor Sweet invariably gives food for thought in his utterances upon practical questions, and in his review and glance forward he gives a glimpse of improvements which may be expected in the machine designs of the near future.

"If the machine tool builder of to-day could fully grasp the revolution that is to come over the trade within the next quarter of a century it would be a revelation to him, and yet a glimmer of what it is to be can be dimly seen. While all the standard machines will still be made and used, they will be built primarily to do work rather than to suit the convenience of the operator, and so improved that they will still be easier for the operator to handle. Instead of the designers studying to find out where they can take out a pound of iron and not have the machine weakened, they will study to find where they can put in another hundred and make it pay in the more and better work the machine will do. They will revolutionize the drive and feed mechanisms so that the workmen can get the best of both without exertion, and they must to a large extent make the machines self-contained and true, wherever they may be set and on whatever they set, for many of the machines are to go to the work and not the work to the machines."

"Great industries permit of great quantities. Special machines will be more largely employed, because then there will be pieces enough of one kind to keep one or more machines employed at a few operations or a single one, and there will be far less idle capital in long machines doing short work and large ones doing small work. When there is enough of a kind the automatic machine will do the work, and inconsistent demands from inconsiderate workmen may in many cases develop automatic machines before even economy justifies their existence."

The entire number is a most interesting review of the work of the individual from whom our valued contemporary takes its name, a record of the work of the machinist in the United States of America.

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# THE ECONOMY OF LARGE SHIPS.

### CAUSES FOR THE INCREASING TENDENCY FOR THE CONSTRUCTION OF VESSELS OF GREAT CARRYING CAPACITY.

*A. W. Robinson—Canadian Society of Civil Engineers.*

THE marked tendency towards increase in size and carrying capacity of ocean steamers is a fact so generally recognized that it needs no comment as such. The causes for this increase, and its influence upon river and harbor work form the subjects of a paper presented before the Canadian Society of Civil Engineers by Mr. A. W. Robinson, from which we make some abstracts.

As to the causes of the development, the facts are not difficult to discover. They are not greatly different from those which have operated to produce similar growth in the capacity of apparatus for transport in all lines of work. In railroad practice the development in the size of cars is well known, and it is a fact that in the past ten years the paying load hauled by a locomotive has been about doubled. This advance has been due to the increase in the carrying capacity of the cars and the hauling power of the locomotives, as well as to the improvement in the roads by reason of the reduction of grades and curves. Railroad men well understand that the cost of transport to them is measured by the train mile, while their charges to the customer are made by the ton mile, so that the commercial reason for the effort to increase the tonnage of the train mile is readily seen.

Much of the great improvement which has been made in the output of manufacturing establishments is due to the introduction of convenient and capacious transport facilities, while in the work of the civil engineer nearly all the appliances which he uses in handling materials have greatly increased in capacity during the past few years.

"In ocean steamships a different state of conditions is found, and as no improvement can be effected in the natural highway of the sea, we must depend entirely upon the development of marine engineering in obtaining higher efficiency in engines and boilers, and in larger carrying capacity of the vessels themselves. It has been found that the propelling power required for a vessel for a given speed increases in a slower ratio than the increase of its displacement, and in this fact is found the main secret of the superior economy of large vessels. A good deal has been done during the past ten years in the improvement of engines and boilers of ships, and in the reduction of weight and space occupied by them, but this improvement is small compared with the increased economy produced by increasing the size alone. During the past ten years the paying load carried by a representative ocean cargo steamer has about doubled, while the average increase in fuel economy has been reduced from 1.52 pounds coal per horse-power per hour to 1.48 pounds—a comparatively small saving."

Constructively, the limitations as to size in shipbuilding have by no means been attained. The "Celtic" is about 700 feet long, 75 feet beam, and 33 feet draught; with a displacement of 33,500 tons, and a gross tonnage of 20,800 tons, and this is about the present limit, not of shipyards and marine engineering, but of harbor draught and port facilities. This fact is realized, partially, at least, and harbors all over the world are being dredged and docks and channels extensively improved to enable larger vessels to enter.

"It is an unnecessary truism to say that large ships will not be economical unless they can be filled, but this aspect of the question merits more than passing notice. The difficulty of providing cargo for these large vessels is very great, and their advantages will not be realized unless there is a corresponding growth all along the line in facilities for receiving, warehousing, and rapid handling of the different kinds of freight in large quantities.

"In the keenness of competition of the present day it is the large economic cargo carrier which will aid the most in the development of ocean trade, and ships of very great speed are only required for the purpose of carrying mails, and for carrying the comparatively small number of passengers who are willing to pay the extra price for the saving of time.

The subject of fast ships is always an interesting one to engineers, as it calls for the highest skill in design and construction, and the problem is no easy one.

It is a great testimony to British shipbuilders that they have been and are still able to produce ships as fast as any in the world, although the Germans have the honours at present with the "Kronprinz Wilhelm," at 23.08 knots, and propose to beat it with the "Kaiser Wilhelm II." now building. It is satisfactory to see that the Cunard Company now propose to build two boats at about 25 knots, under a subsidy arrangement with the British Government, and so the race for supremacy in speed goes on. This is a testimony that British builders stand ready to produce any vessel that the companies are ready to pay for and that great speed is as much a commercial question as an engineering one.

The price of speed is so great that it precludes carrying freight economically or carrying freight at all, and the present tendency of British practice for general freight and passenger service is towards a type of vessel which combines moderate speed with large carrying capacity. It will be interesting to compare the speed and carrying capacity of the two largest ships in the world now building, the "Cedric" and the "Kaiser Wilhelm II."—the "Cedric" representing a type of vessel having large capacity combined with moderate speed, and the "Kaiser William II." representing a type in which everything is sacrificed to speed.

A COMPARISON OF THE TWO GREATEST VESSELS NOW BUILDING.

| | Displacement. | I. H. P. | Speed Knots. | Dead Weight. | Pass. Accom. | Tons Coal Per Day. |
|---|---|---|---|---|---|---|
| "Cedric" .................... | 37,800 | 14,000 | 17 | 18,000 | 3,000 | 260 |
| "Kaiser William II.".......... | 26,000 | 40,000 | 24 | none. | 1,800 | 750 |

It is apparent from the foregoing figures that the extra seven knots speed is obtained at the cost of an additional coal consumption of nearly 500 tons of coal per day, and that the passenger accommodation is much less and the cargo capacity entirely lost. This will give some idea of the enormous cost of high speed."

Mr. Robinson applies the facts thus set forth to the case of the navigation of the St. Lawrence river, but they may be equally used in connection with other harbors and navigable streams. The fact may as well be realized now as later that those ports which expect to retain their commerce must provide same channels of ample depth and proper harbor handling and warehousing facilities for the large steamers. Vessels of 1,000 feet in length and 40 feet or more draught will have to be reckoned with before very long and only those seaports which have prepared themselves for such visitors will be able to reap the advantages of the commerce which such ships will bring.

# ELECTRICALLY-OPERATED TRANSPORT APPLIANCES.

## THE INFLUENCE OF ELECTRIC POWER UPON THE DEVELOPMENT OF CRANES, HOISTS, AND GENERAL CONVEYING MACHINERY.

*Verein Deutscher Ingenieure.*

AMONG the industrial applications of electric power and transmission, one of the first to be made was that of use for operating hoisting and conveying machinery, probably because of the readiness with which the current could be transmitted from a stationary to a moving body. The whole question of the influence of this application of electricity upon the design of machinery for handling materials forms the subject of an important paper presented by Herr Kammerer at the Düsseldorf meeting of the *Verein deutscher Ingenieure,* and published in succeeding issues of the *Zeitschrift* of the Society.

Herr Kammerer first reviews the construction and capacity of hoisting and handling machinery before the applications of electric power, showing how the usual power transmitting system for indoor work was that of the flying rope, while for docks, warehouses, and outdoor service, hydraulic transmission, with all its inconveniences, was in general use. The relation which these systems of power transmission bore to electric power is shown by curves, giving excellent comparative ideas of the relative efficiency of the different methods.

By far the most important advantage of electric power for hoisting and conveying, however, lies in the ease with which the current may be delivered to any moving portion of the machinery from any other part. With this is united the advantage that a motor can be placed upon the very part which is to be operated, thus reducing the elements of the transmitting machinery to a minimum. The fact that the speed of the motor may be regulated at will within all reasonable limits also adds greatly to its availability for this particular service.

Prior to the application of electric driving to the travelling crane, for example, the varied operations of bridge travel, trolley travel, and hoisting, with all their necessary variations in speed and direction, had to be derived from one source of power, delivered to the travelling bridge through the medium of a flying rope, square shaft, or similar inconvenient device. The result was that the complete travelling crane of a decade ago was rightly called one of the most highly organized machines in use, carrying as it did, a mass of gear wheels, shafts, clutches, reversing mechanism, etc., etc., all these complications being increased because of the necessity for transmitting them to the parts moving over the whole space included in a system of rectangular coordinates, commonly expressed by the three terms, bridge travel, trolley travel, and hoist.

The earliest application of electricity to this problem was but a partial solution. The flying rope or square shaft was replaced by an electric contact, and power was thus conveniently delivered to the travelling bridge. Here, however, it was used to operate a single motor, which in turn drove all the same complicated mass of machinery which had formerly been found necessary, and which it was difficult to conceive could be entirely thrown away. The success which attended this imperfect treatment of the subject, however, led almost immediately to the complete realization of the possibilities of the new system, and now all such cranes are made with separate electric motors for each function, thus sweeping away at one stroke the entire collection of transmitting machinery formerly necessary. There is no such example elsewhere to be found which so completely demonstrates the mechanical superiority of electricity for the transmission and subdivision of power and motion.

Apart from the applications to cranes, we have the newer uses permitting designs of machinery for handling materials which could be accomplished only imperfectly with the older means for power transmission. Thus, the various telpherage systems, in which carriages are operated over spans of cable or other supporting structure, are a great improvement over the earlier types of conveyors in which the entire cable was obliged to be kept in motion. The same improvement is seen in the small trolley hoists for use in machine works and warehouses, in which the hoist is suspended from the flanges of an overhead system of beams. These were formerly always operated by hand, and their capacity and speed were correspondingly limited, but now it is possible to equip them with small motors and reserve the human element to the control and application of the power so conveniently made available by electricity.

Herr Kammerer gives illustrations of a great number of applications of electric power to hoisting and handling machinery, showing the great influence which the change has made upon the design and use of such machinery, and the paper forms a most interesting contribution to the development of machine design.

## THE PERSONNEL QUESTION IN THE UNITED STATES NAVY.

### WHY THE PLAN FOR MODERNIZING THE AMERICAN NAVAL SERVICE HAS NOT BEEN FAITHFULLY CARRIED OUT.

*Report of Rear Admiral Melville.*

SO much has already been said in these columns concerning the failure of the Navy Department of the United States to carry out the clear meaning of the Personnel Bill that it seems as if there was little more which could be added to penetrate the consciousness of those to whom the administration of the laws has been entrusted; but the closing portions of the report of the Engineer-in-Chief show that the matter is not yet settled. This is the more surprising from the fact that the President of the United States, when Assistant Secretary of the Navy, uttered the comprehensive words:

"Every officer on a modern war vessel in reality has to be an engineer, whether he wants to or not. Everything on such a vessel goes by machinery, and every officer, whether dealing with the turrets or the engine room, has to do an engineer's work. There is no longer any reason for having a separate body of engineers, responsible for only a part of the machinery. What we need is one homogeneous body, all of whose members are trained for the efficient performance of the duties of the modern line officer. The midshipman will be grounded in all these duties at Annapolis, and will be perfected likewise in all of them by actual work after graduation. We are not making a revolution; we are merely recognizing and giving shape to an evolution which has come slowly but surely and naturally, and we propose to reorganize the navy along the lines indicated by the course of the evolution itself."

Admiral Melville calls attention to the fact that the bill was criticised at the time of its passage because it did not make explicit provision for compelling the enforcement of engineering duty. President Roosevelt had no such scruples, but, as above quoted, recognized the fact that officers would not want to become engineers.

It was maintained that departmental orders and regulations would be promulgated to enable the spirit of the bill to be carried out, but experience has shown that nothing short of a club will induce a line officer to become an engineer. To quote again the words of President Roosevelt: "He has to be an engineer, whether he wants to or not."

That this state of affairs is not creditable to the navy of the United States must be admitted, but apparently it cannot be helped. These men doggedly oppose the clear intent of the personnel bill, and hiding behind the omission of any provision for the enforcement of the bill, continue to decline to stand engine-room watch, or to fit themselves for the responsibilities for which they are drawing pay.

At the present time the bulk of the engineering work in the navy is being performed by warrant machinists. That this can make up for the delinquencies of the officers, Admiral Melville does not believe. Says he:

"While the warrant machinists have had shop training and experience at sea, it can not be expected that they possess the necessary scientific training to enable them to take up the most important duties that were performed in the past by the commissioned officers of the old Engineer Corps. These men may have the skill to adjust bearings, set a valve, replace a water tube in a modern marine boiler, overhaul a pump, and possess the requisite knowledge for operating machinery with which they are familiar, but in matters of organization the services of more highly trained men are needed. There are great laws of mechanics, physics, chemistry, and thermodynamics which must be put to practical application by the chief engineer of a war ship. It is a thorough grasp of these principles, combined with practical sea experience and power of observation and study, which makes the competent marine engineer.

"It is not my desire to disparage the work of the warrant machinists. These men are rendering useful and efficient service, and provision should be made whereby the elect might quickly secure commissions in the Navy. It is my great desire to encourage them and advance their material interests, but as a rule this class of officers can no more do the work of trained and educated engineers than can carpenters take up the duty of naval constructors, gunners assume the responsibility devolving upon ordnance experts, or boatswains attain the skill and executive ability of skilled sea commanders."

Although the enactment of the personnel bill was received with adverse criticism from naval officers of various countries, Admiral Melville does not share in the belief that it was a mistake. On the contrary he says:

"The principle of amalgamating the duties of the line and engineer officers is in accord with the trend of modern development, and it is by reason of this fact that the proposition received the hearty and unqualified support of the engineering interests throughout the country. It was an official recognition on the part of Congress, of the dignity and importance of the engineering profession. It was also an emphatic declaration on the part of the legislative assembly that an organization which was suitable for vessels of oak was not compatible for the needs of ships of steel, and that the men beneath the protective deck in the engine rooms and stokeholds were as much an integral part of the ship as the men who served and trained the guns. This legislation, however, assailed the traditions of the service, and it was not surprising that opposition developed when it was presumed that vested rights had been encroached upon. This opposition was powerless in its appeal to Congress to reject the measure. It commanded greater strength within the naval service, and it is this influence which stands in the way of a liberal and generous enforcement of the unwritten, but well understood provisions of the personnel law."

"If the law is administered with a desire to make it a success, it will beyond a doubt give us the most efficient navy in the world. It must, however, be administered in a way that will prevent junior officers from showing a decided preference for deck duty, and this result can in great part be secured by refusing to promote those who have not had actual and continuous experience in the engine room, and whose semi-annual reports as to fitness do not show that they have been zealous and proficient in the performance of engineering duty."

No additional legislation is needed for the proper execution of the personnel law. It is only necessary that the President, under whose personal auspices as assistant Secretary of the Navy the bill was prepared, shall appoint a Secretary of the Navy who realizes that it is his plain duty to make every officer in the navy an engineer, "whether he wants to be or not."

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# POSSIBILITIES IN LOCOMOTIVE DESIGN.

## A COMPARISON IN DEVELOPMENT OF AMERICAN AND EUROPEAN TYPES AND THEIR MUTUAL INFLUENCE UPON FUTURE ENGINES.

*An Address by Professor W. F. M. Goss.*

THE difference in appearance which every traveller notices in the locomotive engines of various countries is a matter which has often received comment, and while the engineer knows that these differences are mainly in detail, and not in general principle, it has generally been thought that each type was the outgrowth of the necessities of its peculiar locality. While this is true to a limited extent it is much less so than many imagine, and there is little doubt that the locomotive of the future, at least until steam is displaced by electricity, will tend more and more toward an international type, combining the experience of many places and men.

So far as the American locomotive is concerned, the conditions which led to its present form are clearly set forth in an interesting address delivered by Professor W. F. M. Goss at the Deer Park convention of Baltimore & Ohio officers, and published in a recent issue of the *Railroad Gazette.*

Passing the early experimental period, the American locomotive took the fundamental elements of its present form during the great period of activity between 1850 and 1860, when the railway mileage of the country increased from 8,000 miles to 29,000 miles, or nearly 260 per cent., much of this growth being in new and partially developed parts of the land.

"The effect of this expansion upon the design of locomotives was great. As these thousands of miles of road extended themselves over the country, their equipment became necessary. Locomotives were in demand. These could not often be supplied by the railroad companies themselves, for their energies were being expended in extending lines, and, in most cases, they were without facilities for producing them. In these early days the officials of the roads had little time in which to give either thought or suggestion concerning the details of equipment, and the builders of locomotives, with an abundance of orders in hand, and with no highly-organized staff of designers to study the needs of individual roads, followed naturally the lines of least resistance. It was to have been expected under these conditions that each builder would supply all customers with engines of the same general type, and it was equally natural that each should seek to strengthen his own practice by the experience of his neighbors. In this manner, each contributing something to the solution of the common problem, there gradually came into existence a distinct and generally-adopted design, the American-type locomotive, a development by experimental processes, from very early beginnings."

The growth of railroad construction in the United States continued from 1860 to 1890 without material change, the enormous demand for locomotives continuing as the construction mileage of the country grew, until at the close of the eighties the railways of the United States reached the total of more than 163,000 miles. Such a demand called for properties which the American locomotive met very effectively. Fuel economy was a minor consideration. The engines were constructed to meet other requirements.

"With their 16 in. or 17 in. cylinders and 120 or 140 lbs. of steam, they carried good loads and ran at fair speeds. They responded perfectly to the demands of a mixed service, sometimes doing switching, sometimes pulling a freight, and sometimes a passenger train. They were sufficiently flexible to be but little affected by roughness of track, and their parts, being few and strong, were not often deranged or broken. The efficiency of these engines, both as to boiler performance and cylinder action, is probably not exceeded by that of the modern simple locomotive. When to these obvious advantages, there is added a low first cost and a low cost of repairs, the preference which has been accorded the American type is readily explained."

About a dozen years ago the conditions changed, and with the cessation in railroad building and the diminution in demand for engines the business declined, and upon its revival it was found that new conditions had to be met. There is now a demand for higher efficiency in the operation of trains, and locomotives are more generally required to be designed for specific services.

The great claim for the older type of American locomotive was its simplicity, and many valuable improvements were condemned on the ground of their complication. Fear of complication has to a great extent passed away, and very naturally, too, in view of the increasing complication of all departments of work and life. As Professor Ayrton well said, upon another occasion, the graduated candle of King Alfred was infinitely simpler than the modern watch, but no one thinks of discarding his watch to-day on that account.

Leaving aside, then, the limitations set by the older designers, Professor Goss proceeds to examine the lines along which locomotive improvement may be expected. First among these he places the handling of the fuel. It cannot be accepted that the development of the locomotive can be retarded by the fact that its power is to be measured by the physical ability of one man to feed its furnace. There are several alternatives, among which may be mentioned oil fuel, powdered coal, and mechanical stokers; certainly however this may be, there is little doubt that the capacity of some existing engines could be increased 10 to 20 per cent. if they could be adequately fired.

Steam economy, until now a secondary consideration, has come to the front, not so much for the purpose of saving coal as for the necessity of increasing the ratio of boiler to engine power. This leads at once to the consideration of compounding.

"As a general proposition, compound cylinders require less steam than simple cylinders for the development of a given amount of power. A saving in steam implies a reduction in the quantity of water to be handled, and hence, compounding should prove advantageous in localities where water is scarce or bad. A saving in steam also implies a reduction in the amount of coal required to perform a given service, and, hence, compounding should be popular wherever fuel is expensive. A saving in the amount of steam used per horse-power per hour permits the development of greater cylinder power in connection with a boiler of given dimensions and weight, so that compounding becomes a means by which the limit of power may be raised when the weight of the locomotive as a whole has been fixed."

Since this question of compounding has reached a further development in Europe than in America, it is here that the influence of European locomotive design upon American construction must be expected to show the greatest influence. Including the question of balancing, there is every reason to believe that the four-cylinder compound type of M. de Glehn, extensively used on the Continent, presents many advantages. The early American prejudice against cranked axles may well be abandoned, in view of the better material and construction now existing, as well as the improved condition of American road-beds, permitting sufficiently smooth running to insure against axle breakages.

Professor Goss makes an excellent argument to show that the simplest machine is not always that which has the fewest parts. Upon this important question we may be permitted to quote his own words only emphasising the strength of his position by affirming our full agreement with his conconclusions.

"An excellent example of this is had in the case of certain marine engines. Both in merchant and naval service, four-cylinder triple-expansion engines are now not uncommon. It is true that three cylinders would be sufficient to satisfy the thermodynamic conditions involved, but if only three cylinders are used, the volume required for the last expansion necessitates the use of a low-pressure cylinder of dimensions too great to be conveniently handled or operated. Under such conditions, two low-pressure cylinders, each having half the required volume, are employed, and, so far as I know, no one has ever attempted to argue that the addition of parts thus involved in any way increases the chances of derangement or delay. On the other hand, the whole effect of the sub-division is to give increased security against such delay. Is not the time at hand when improvement in this line will be made by a sub-division of some of the larger parts of the American locomotive? Believing such a change imminent, I have hopes that in securing the advantages of such a sub-division, the opportunity which presents itself, both for compounding and for perfect balancing, will not be allowed to pass unimproved.

"I look forward, then, to the representative American locomotive of the future, as an engine capable of exerting even greater power than the modern engine. I predict that it will be automatically supplied with fuel; its thermodynamic performance will be made high through the adoption of compound cylinders, and its mechanical action perfect, through the balancing of its reciprocating parts. With such a locomotive and with a track which is in keeping with the improved action of the locomotive which is to run upon it, the present generation will not need to blush when called upon to give over its responsibilities to that which is to follow."

# THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages from a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

*We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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## CIVIL ENGINEERING

### BRIDGES.

**Cologne.**

The Competition for a Second Fixed Bridge over the Rhine at Cologne (Der Entwurf zu einer Zweilen Festen Rheinbrücke in Köhn). M. Foerstner. With illustrations of the proposed suspension truss bridge of 220 metres clear span. 1800 w. Schweizerische Bauzeitung—Sept. 27, 1902. No. 51336 B.

**Collapse.**

Collapse of a 200-foot Highway Bridge Over the Colorado River at Gonzales, Tex. Brief illustrated account of an accident caused by the failure of one of the double-cylinder piers on which is was carried. 800 w. Eng News—Oct. 9, 1902. No. 51093.

**Concrete Arch.**

Warped Ends for Concrete Arch Culverts. Daniel B. Luten. Illustrates and describes four structures built under the writer's supervision in which wings and parapets were omitted, the arched ring being finished in the warped-end style, giving reasons for the adoption. 1700 w. R R Gaz—Oct. 3, 1902. No. 50934.

**Construction.**

Bridge and Building Construction on the Louisville & Nashville R. R. General plans of some of the structures with account of progress. Ill. 7000 w. Ry & Engng Rev—Oct. 18, 1902. No. 51211.

**Costa Rica.**

The Rio Grande Bridge of the Pacific Railway of Costa Rica. An illustrated description of the construction and erection of this bridge on the Pacific Railway of Costa Rica, with information concerning the country, the engineering difficulties, etc. 4400 w. Eng Rec—Oct. 25, 1902. Serial. 1st part. No. 51240.

**Danube.**

King Charles I. Bridge Across the Danube. Nicolae Ionescu. An account of the circumstances which led to the building of the bridge, the conditions to be met, and an illustrated description of the structures. 1000 w. Sci Am—Oct. 25, 1902. No. 51290.

**Double-Deck.**

A Four-Truss Double-Deck Railroad Bridge. Illustrated detailed description of a bridge across the Allegheny River which was required to carry two pairs of tracks at different fixed levels. 3500 w. Eng Rec—Oct. 11, 1902. Serial. 1st part. No. 51110.

**Highway.**

Highway Bridge of 465-Ft. Span Over the Miami River, at New Baltimore, Ohio. Elevation and plan with description of one of the longest highway bridge spans in the United States. 700 w. Eng News—Oct. 16, 1902. No. 51218.

**Philadelphia.**

The Pennsylvania R. R. Bridge at Fifty-second Street, Philadelphia. Illustrates details and describes a bridge built to avoid a grade crossing. It includes two long viaduct approaches and a single through span, weighing about 900 tons. 2200 w. Eng Rec—Oct. 25, 1902. No. 51-242.

**Reconstruction.**

Reconstruction of a Railway Bridge Near Mayence. An illustrated account of the various stages of the work. Each of the old 115 ft. flood spans was, in a space of two hours, replaced by a new one weighing nearly 80 tons. 900 w. Engr, Lond—Oct. 10, 1902. No. 51176 A.

**Thames.**

New Kew Bridge. The present article deals with the removal of old foundations, describing the construction work, and giving illustrated description of construction details of the new bridge. 1800 w. Engr, Lond—Sept. 26, 1902. Serial. 1st part. No. 50967 A.

**Viaduct.**

Launching the Metallic Superstructure of the Viaduct over the Rhone at Avignon (Lançage de la Superstructure Métallique du Viaduc sur le Rhône à Avignon). Describing the erection of this important railway bridge. There are six spans of 73 metres each and two of 58 metres. 2000 w. 1 plate. Rev Gen des Chem de Fer—Oct., 1902. No. 51379 H.

## CANALS, RIVERS AND HARBORS.

**Barge Canal.**

The Ontario Route for a Barge Canal vs. the Seneca-Oneida-Mohawk Route. T. W. Symons. An argument against the Ontario route and in favor of the inland route, with editorial discussion. 4800 w. Eng News—Oct. 2, 1902. No. 50926.

**Breakwater.**

Projected Breakwater at Alicante (El Dique de Abrigo Proyectado de Alicante). José Nicolau. A general review of the existing conditions of navigation and the proposed improvements at the port of Alicante, Spain. 2500 w. 2 plates. Revista de Obras Publicas—Sept. 4, 1902. No. 51351 D.

**Dredging.**

A New Clam Shell Dredge Operated by Compressed Air. Illustrates and describes a recent invention of E. Chaquette for closing and opening a clam shell for subaqueous excavation. 1100 w. Compressed Air—Oct., 1902. No. 51233.

**Emden.**

See Electrical Engineering, Generating Stations.

**Ireland.**

Irish Canals: Their History and Influence on Trade. Abstract of a paper by A. W. Shaw, read at a meeting of the Limerick Chamber of Commerce. 1400 w. Transport—Oct. 17, 1902. No. 51408 A.

**Isthmian Canal.**

An Alternative Line for the Nicaragua Canal; and a Proposed New Method of Dam Construction. J. Francis Le Baron. Considers the Colorado mouth as a much more desirable harbor, describing how it can be made available. Proposes a loose-rock dam, enclosed in a heavy chain-cable net. Ill. and map. 6000 w. Pro Am Soc of Civ Engrs—Oct., 1902. No. 51-252 E.

The Need of an American Isthmian Canal. W. J. Manson. Discusses trade and domestic advantages, shipping interests, etc., briefly reviewing the subject of a selection of a canal route. 2500 w. Marine Engng—Oct., 1902. No. 51011 C.

**Lock Gates.**

Iron or Wooden Lock Gates: Cost of Construction and Maintenance. Points from the summary, by Mr. Fulscher, of reports presented at the Düsseldorf navigation congress. 1400 w. Eng News—Oct. 9, 1902. No. 51095.

**Nile.**

The Nile Dams. A review of the important works already completed, with four 2-page plates. 7500 w. Builder—Sept. 20, 1902. No. 50854 A.

**River Improvement.**

Improvement of the Black Warrior, Warrior and Tombigbee Rivers, in Alabama. Continued discussion of paper on this subject by R. C. McCalla. 13000 w. Pro Am Soc of Civ Engrs—Oct., 1902. No. 51253 E.

**Scheveningen.**

The Harbor of Scheveningen (De Binnenhaven te Scheveningen). P. J. Van Voorst. Data concerning the dredging of the harbor, breakwater construction and general improvements. 7000 w. De Ingenieur—Sept. 27, 1902. No. 51367 D.

**Streams.**

Limiting Width of Meander Belts. Prof. Mark S. W. Jefferson. A study, seeking to establish a limit for the width of the belt of meanders of any given stream. Ill. 3300 w. Nat Geog Mag—Oct., 1902. No. 51029 C.

## CONSTRUCTION.

**Building Construction.**

The Philadelphia Company's Building, Pittsburg. Illustrated description of the foundation and steel-work of a high office building. 3500 w. Eng Rec—Oct. 4, 1902. No. 50946.

**Columns.**

Columns for Buildings. John Stephen Sewell. Describes the concrete-filled columns in the new Government Printing Office at Washington, and gives the writer's views. Also editorial and letters. 6600 w. Eng News—Oct. 23, 1902. No. 51284.

**Dam.**

A Concrete Power Dam at Middle Falls, N. Y. Illustrated description of a dam having long spillways at each side at right angles to its axis. 1200 w. Eng Rec—Oct. 4, 1902. No. 50944.

**Masonry.**

The Cause of Masonry Disintegration. Halbert Powers Gillette. Arguing that masonry destruction in cold climates is due primarily to stresses developed by expansion and contraction due to changes in temperature. 2800 w. Eng News—Oct. 23, 1902. No. 51285.

**Military Engineering.**

The Engineer in the Moro Campaign. An account of the extent to which engineering work has participated in the campaign of the American troops against the Moros in the Philippines. 2000 w. Engineering Magazine—November, 1902. No. 51398 B.

**Pile Drivers.**

Modern Pile Drivers. Waldon Fawcett. Considers some of the characteristics of modern pile-driving machinery, and the severe requirements to be met. Ill. 1000 w. Sci Am—Oct. 4, 1902. No. 50935.

**Roads.**

A Study of Road-Building Gravels. Ira O. Baker. Discusses the requisites for a good road gravel, and gives results of a study of a number of well-known gravels. 3500 w. Eng News—Oct. 23, 1902. No. 51286.

How to Lay Portland Cement Flagstone Walks. F. H. Crafts. Gives details of construction, with illustrations of tools used. 1500 w. Munic Engng—Oct., 1902. No. 50872 C.

Improvement of a Mountain Highway in Austria. Condensed translation from *Oesterreichische Monatschrift für den Oeffentlichen Baudienst*, describing work on the Karlstadter highway. 1500 w. Eng Rec—Oct. 11, 1902. No. 51115.

**Tunnels.**

The Simplon Tunnel. Illustrations and interesting information concerning this great engineering work. 2200 w. Transport—Sept. 26, 1902. No. 50916 A.

## MATERIALS.

**Building Material.**

Quarzitol: New Brick in Germany. An account of a new brick made of flinty sand and some chemical binding material, water and fire-proof and claiming many advantages. 1400 w. U S Cons Repts, No. 1476—Oct. 23, 1902. No. 51230 D.

**Cement.**

A New Definition of Portland Cement. A. D. Elbers. 500 w. Sci Am Sup—Oct. 4, 1902. No. 50941.

Some Frost and Adhesion Tests of Cement Mixtures. Abstract from a paper by James S. Costigan, describing special tests made of this material. 1300 w. Eng News—Oct. 2, 1902. No. 50924.

The Manufacture and Testing of Portland Cement (Die Fabrication und Prüfung von Portlandcement). Theodor Pierus. A general account of the development of the manufacture of Portland cement, with especial reference to the growth of the industry in Germany. 9000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 3, 1902—No. 51324 B.

**Fire Proofing.**

Fire Test of a Lock-Woven Metal Concrete Floor. Describes a test made and reported by W. W. Ewing. Ill. 1100 w. Eng Rec—Oct. 11, 1902. No. 51117.

**Reinforced Concrete.**

Experimental Researches upon the Resistance of Reinforced Concrete to Compression (Etude Experimentale de la Resistance á la Compression du Beton Fretté). M. Considère. An account of experiments made to show the relation between the computed and actual crushing strength of hooped prisms. 1800 w. Comptes Rendus—Sept. 8, 1902. No. 51375 D.

Structures in Armed Cement (Il Cemento Armato). A description of the construction of culverts and viaducts in reinforced concrete on the line of the Southern Railway of Italy. 2500 w. Il Monitore Tecnico—Oct. 10, 1902. No. 51370 D.

The Resistance of Reinforced Concrete to Tension (Résistance à la Traction du Béton Armé). M. Considère. A discussion of the tests made by the Department of Public Works, showing the influence of the metallic reinforcement upon the elasticity. 1500 w. Comptes Rendus—Aug. 18, 1902. No. 51373 D.

The Resistance of Reinforced Concrete to Compression (Etude Theorique de la Résistance à la Compression du Béton Frette). M. Considère. A study of the increase produced in pillars of concrete by surrounding them with metallic hoops. 1800 w. Comptes Rendus—Aug. 25, 1902. No. 51374 D.

**Sand and Gravel.**

A Study of Hard-Packed Sand and Gravel. W. O. Crosby. Describes material encountered in the modified drift of the Nashua Valley, south of Clinton, Mass., and a series of tests made. 1400 w. Tech Qr—Sept., 1902. No. 51126 E.

**Sand-Binder.**

Marram Grass as a Sand-Binder, in Victoria-Australia. A report of the writer's experience and the method adopted. 800 w. Eng News—Oct. 23, 1902. No. 51281.

**Structural Steel.**

The adoption of a single Grade of Steel in Structural Specifications. Albert J. Hines. Arguments favoring the adoption for all ordinary requirements, but allowing the making of special steels for unusual requirements. 1400 w. Eng News—Oct. 23, 1902. No. 51282.

**Uralite.**

The Manufacture of the New Fireproof Material Uralite. Illustrates and describes this new material which originated in Russia and takes its name from the Ural Mts., giving the process of manufacture, the notable features, tests, etc. 2000 w. Sci Am—Oct. 4, 1902. No. 50938.

Uralite: New Fireproof Material. A description of this material, its various advantages and uses. 2000 w. U S Cons Repts, No. 1463—Oct. 7, 1902. No. 50942 D.

## MEASUREMENT.

**Slide Rule.**

The United States Geological Survey Topographic Slide Rule. Gerald H. Matthes. Illustrated description of this slide rule, designed by the writer, with an outline of problems demonstrating its use. 3300 w. Tech Qr—Sept., 1902. No. 51125 E.

## MUNICIPAL.

**Baths.**

The Brookline Baths. Waldon Fawcett. A description of these public baths, the first municipal bath of its kind in the United States, with information relating to their use, cost, etc. 2000 w. Munic Engng—Oct., 1902. No. 50871 C.

**Pavements.**

The Development of the Bituminous Macadam Pavement. Fred J. Warren. Abstract of a paper presented to the Am. Soc. of Munic. Imp. Describes a pavement combining the essential principles of both asphalt and macadam, giving the theories on which the construction is based. 2300 w. Eng Rec—Oct. 11, 1902. No. 51116.

The Maintenance of Asphalt Streets. Discussion of paper by James N. Hazlehurst. 8500 w. Pro Am Soc of Civ Engrs—Oct., 1902. No. 51254 E.

The Use of Wood Pavements Under Heavy Traffic. F. A. Kummer. Abstract of a paper presented to the Am. Soc. of Munic. Imp., showing that wood blocks laid with a tight joint, with selected wood and latest practice of construction, show a fine record as to wear. 1500 w. Eng Rec—Oct. 18, 1902. No. 51221.

**Refuse Disposal.**

Refuse Destructors. W. Francis Goodrich. A review of progress with discussion of systems, apparatus, costs, etc. 3300 w. Mech Engr—Oct. 18, 1902. Serial. 1st part. No. 51409 A.

**Sanitation.**

Report of the Chairman of the Committee on Sewerage and Sanitation. Prof. A. Prescott Folwell. Presented to the Am. Soc. of Munic Imp. Considers municipal sanitation, food inspection, baths, drainage, etc. 3800 w. Eng Rec—Oct. 18, 1902. No. 51223.

**Sewage.**

A Dozen Years' Experience in Sewage Purification at Santa Rosa, Cal. Reviews the early experiences and describes the combination of septic tanks, settling tank, and upward filtration now in use. Ill. 1000 w. Eng News—Oct. 2, 1902. No. 50923.

Residential Septic Tanks. Burton J. Ashley. Presented to the Am. Soc. of

Munic. Imp. Describes an arrangement for sewer service which proved an excellent septic tank, and the application of the idea on an extensive scale with satisfactory results. 2200 w. Eng Rec—Oct. 11, 1902. No. 51114.

Sewage Disposal Works at Nuneaton, England. Describes a system which deals successfully with sewage receiving waste from the works of wool scourers, fellmongers and hat factories. 1400 w. Eng Rec—Oct. 4, 1902. No. 50945.

The Purification of Sewage Water (Epuration des Eaux d'Egout). G. Richon. A discussion of the use of combined chemical and biological processes, as used in Belgium and in Austria. 2500 w. Génie Civil—Sept. 13, 1902. No. 51-301 D.

The Second Report of the Royal Commission on Sewage Disposal. Reviews the collection of reports issued by the commission, dealing with some of the bacterial phases of sewage and with the pollution and self purification of the River Severn. 4000 w. Eng News—Oct. 9, 1902. No. 51099.

The Treatment of Manchester Sewage. G. J. Fowler. Abstract of a paper read before the Sanitary Inst. Congress. Gives an account of experiments carried out to determine the best treatment for the sewage of this city, and the conclusions reached. 3200 w. Engng—Oct. 10, 1902. Serial. 1st part. No. 51173 A.

**Sewers.**

A Concrete-Steel Sewer. Describes and illustrates an interesting work to be constructed in Harrisburg, Pa. The sewer is to intercept the ordinary flow of a system of combined sewers in a district lying on both sides of a small stream which has been receiving these liquids. 3200 w. Eng Rec—Oct. 11, 1902. No. 51111.

An Important Main Drainage Scheme for Glasgow. A. B. McDonald. Notes describing the important scheme for the collection and treatment of sewage. 2000 w. Arch't, Lond—Oct. 3, 1902. No. 51-058 A.

## WATER SUPPLY.

**Aqueduct.**

The Weston Aqueduct of the Metropolitan Water-Works, Boston. Alfred D. Flinn. Illustrates and describes details of the construction of an aqueduct designed for a capacity of 300,000,000 gals. per day, and nearly 13½ miles long. 4200 w. Eng Rec—Oct. 14, 1902. Serial. 1st part. No. 51220.

**Brooklyn.**

Proposed Further Development of Underground Water Supply for Brooklyn. I. M. de Varona. From the report of the N. Y. Dept. of Water Supply, Gas and Electricity for the quarter ending June 30, 1902. Illustrates different methods of collecting underground water, with outline of plan proposed. 1800 w. Eng News—Oct. 9, 1902. No. 51100.

**Edinburgh.**

The New Edinburgh Water-Works. An outline of the construction of Tolla reservoir, with the necessary pipe track, aqueducts and tunnels. The work may not be completed for three years, and may cost nearly one million sterling. It will add 10,000,000 gallons a day to the present supply. 2500 w. Engr, Lond—Oct. 3, 1902. No. 51088 A.

**Irrigation.**

Irrigation in South Africa. Extracts from the report of W. Willcocks, who was sent to examine the irrigation possibilities of Cape Colony, the Orange River Colony and the Transvaal. 3400 w. Jour Soc of Arts—Oct. 10, 1902. No. 51155 A.

The Scope and Purpose of the Irrigation Investigations of the Office of Experiment Stations. Elwood Mead. From the report of the office of Experiment Stations. Relates the investigations made of the arid and subhumid portions of the United States, and its insular possessions. 6000 w. Eng Rec—Oct. 18, 1902. No. 51224.

**Pollution.**

Stream Pollution and Its Pecuniary Damage to Natural Water Resources. Marshall O. Leighton. Read before the Central States Water Works Assn. Shows the value of water as a source of wealth as long as unpolluted, and reviews the damage done to the Passaic river in New Jersey, giving an outline of the work of the division of hydrography of the United States Geological survey. 2000 w. Munic Eng—Oct., 1902. No. 50873 C.

**Reservoirs.**

A Reservoir Break at Camden, N. J. An account of a failure due to overfilling, with illustrations. 1000 w. Eng Rec—Oct. 11, 1902. No. 51112.

The Failure of the Water-Works Dam at Utica, N. Y. Particulars of the accident, with photographs. The cause seems to be in the material used in making the upper 25 ft. at the north end of the dam. 700 w. Eng News—Oct. 9, 1902. No. 51096.

**Submerged Mains.**

Submerged Pipe. A. L. Holmes. Read before the Central States Water Works Assn. Considers methods of laying the pipes, and their care and protection; and difficulties and troubles due to improper work. 2000 w. Munic Engng—Oct., 1902. No. 50874 C.

# ELECTRICAL ENGINEERING

## COMMUNICATION.

### Automatic Systems.

Automatic Telephone System (Vollautomatisches Nebenstellensystem für Fernsprechanlagen). J. Baumann. A description of the improved equipment of the German Post Office telephone system. 5000 w. Elektrotech Zeitschr—Oct. 9, 1902. No. 51364 B.

Faller Automatic Telephone Exchange. An illustrated description of this system. 2500 w. Sci Am—Oct. 11, 1902. No. 51052.

### Cables.

Dr. Muirhead's New Mode of Transmission and Relay for Cables. John Munro. Begins a description of this invention, giving an account of the work in this field. 2200 w. Elec Rev, Lond—Oct. 3, 1902. Serial. 1st part. No. 51083 A.

### Light-Telephony.

Recent Experiments in Light Telephony (Neuere Versuche mit Lichtelephonie). Ernst Ruhmer. Describing experiments recently conducted on the Wannsee, near Berlin. Communication was had for a distance of 3.8 kilometres by means of light waves received by a telephone. 3000 w. Elektrotech Zeitschr—Sept. 25, 1902. No. 51356 B.

### Multiplex Telegraphy.

The Rowland Multiplex System of Page Printing Telegraphy. Illustrated detailed description of the system invented by Prof. Henry A. Rowland. 3300 w. Sci Am—Oct. 25, 1902. No. 51291.

The Rowland Rapid Telegraph System. Begins an illustrated detailed description of this system and its operation. It is a multiplex duplex system, having a capacity of four different signals each way on one wire in one-quarter second. 3700 w. Elec Wld & Engr—Oct. 18, 1902. Serial. 1st part. No. 51197.

### Printing Telegraph.

The Electric Typograph (L'Electro-Typographe). A. Lavezzari. A description of the Meray-Rozar apparatus by means of which a composing machine may be operated electrically at a distance. 6000 w. Mem Soc Ing Civ de France—Aug., 1902. No. 51327 G.

### Space Telegraphy.

A Review of Wireless Telegraph Engineering Practice. A. Frederick Collins. A discussion of the basic principles of space telegraphy followed by fully illustrated descriptions of the principal systems. 6000 w. Engineering Magazine—November, 1902. No. 51397 B.

Apparatus of the Braun-Siemens & Halske System of Wireless Telegraphy. Illustrated detailed description. 2000 w. Elec Wld & Engr—Oct. 4, 1902. No. 51022.

Magnetic Detectors in Space Telegraphy. Ernst Wilson. Read at the Belfast meeting of the British Assn. Describes experimental investigations. 1100 w. Elec Engr, Lond—Sept. 19, 1902. No. 50851 A.

Signaling Through Space Without Wires. A. Frederick Collins. Discussing the various claims made by investigators as to priority. 2000 w. Elec Wld & Engr—Sept. 27, 1902. No. 50844.

Some New Detectors for Wireless Telegraphy. A. Frederick Collins. Illustrates and describes various new types, stating the advantages claimed. 1800 w. Sci Am—Oct. 4, 1902. No. 50936.

The De Forest Wireless Telegraph System. Illustrates and describes features of this system. 1000 w. Elect'n, Lond—Oct. 3, 1902. No. 51076 A.

The Slaby-Arco System of Space Telegraphy (Apparecci Slaby-Arco per Radio-telegrafia). A general description of the system, with illustrations of the apparatus at Bremerhaven and on the "See Adler," and fac simile of received message. Two articles. 2000 w. L'Elettricita—Sept. 21, 28, 1902. No. 51381 each B.

Wireless Telegraphy by the DeForest System. A. Frederick Collins. Illustrated description of apparatus used in this American system, with particulars relating to it. 1500 w. Elec Rev, N. Y.—Oct. 25, 1902. No. 51272.

Wireless Telegraphy by the Slaby-Arco System. A. Frederick Collins. Illustrated detailed description of the apparatus used and of the theory of syntonized and multiplex spark telegraphy. 2500 w. Elec Rev, N. Y.—Sept. 27, 1902. No. 50840.

Wireless Telegraphy in Germany. An illustrated detailed description of the apparatus used in the Slaby-Arco system. 3000 w. U S Cons Rept, No. 1457—Sept. 30, 1902. No. 50834 D.

### Telegraphy.

The Experiences of a Telegraph Engineer in Perak State, 1898-1901. D. P. Reid. An account of some of the troubles encountered in the Malay Peninsula. 2500 w. Elec Rev, Lond.—Oct. 3, 1902. Serial. 1st part. No. 51081 A.

### Telephony.

A New Telephone Relay. Illustrates and describes a novel method of reinforcing telephone currents recently patented by Joseph Lyons. 1200 w. Sci Am Sup—Oct. 18, 1902. No. 51205.

Practical Telephony. This first of a series of articles explains some of the terms used. 1500 w. Telephony—Oct., 1902. Serial. 1st part. No. 51035.

The Future of the Telephone in the United Kingdom. J. E. Kingsbury. Read at Belfast meeting of the British Assn. A review of the history of telephony in England, endeavoring to remove misunderstandings and considering the features upon which the service depends. 5500 w. Elec Engr, Lond.—Sept. 19, 1902. No. 50850 A.

The Toledo Home Telephone Company. A. E. Dobbs. Reviews the history of telephony in this city and gives an illustrated description of this new company's building and its equipment. 2700 w. Elec Rev, N. Y.—Oct. 13, 1902. No. 51184.

## DISTRIBUTION.

**Conductors.**

The Determination of the Section of Conductors (Détermination de la Section des Conducteurs). M. Warluzel. Giving formulas for the computation of electrical conductors for a great variety of arrangements, with examples of their application. 3000 w. Revue Technique—Sept. 25, 1902. No. 51309 D.

**Conduits.**

The Joint Use of Underground Conduits for High and Low Tension Wires. Charles F. Hopewell. Abstract of a paper read before the International Assn. of Munic. Elect'ns. Considers the causes of explosions and burnouts, and what the requisite separation should be between the high and low-tension wires to ensure safety. 2200 w. Eng News—Oct. 16, 1902. No. 51217.

**Insulation.**

See Electrical Engineering, Measurement.

**Polycyclic Systems.**

The Polycyclic Distribution of Electricity. Explains the term and states the claims made for the system. Especially considers the Arnold-Bragstad-laCour system, and the validity of their claims. 2000 w. Elec Rev, Lond.—Sept. 26, 1902. No. 50957 A.

**Power Distribution.**

Distribution of Energy for Tramway, Lighting, and Power Purposes. A résumé of the latest information available on the distribution of power over a moderate sized area. 12200 w. Elec Engr, Lond.—Oct. 17, 1902. No. 51417 A.

The "Midland" Electric Power Distribution. Begins an illustrated detailed description of the plant of this company, also describing the location, and giving information of general interest. 4200 w. Elect'n, Lond.—Oct. 3, 1902. Serial. 1st part. No. 51075 A.

**Rotary Converters.**

Notes on the Practical Working of Rotary Converters. J. R. Salter. An illustrated article aiming to demonstrate the flexibility of the rotary converter when employed in a combined alternating and continuous current station. 1900 w. Elec Rev, Lond.—Oct. 17, 1902. No. 51406 A.

**Switch.**

Improved Automatic Switch (Neue Selbstchalter). Max Vogelsang. An illustrated description of the new switch of Voigt & Haeffner, adapted for use with high-tension currents without danger. 3000 w. Elektrotech Zeitschr—Sept. 18, 1902. No. 51355 B.

**Testing.**

See Electrical Engineering, Measurement.

## ELECTRO-CHEMISTRY.

**Batteries.**

Point of Cut-Off in a Battery Discharge. Carl Hering. A discussion of possible solutions of this question. 1800 w. Trans Am Inst of Elec Engrs—June & July, 1902. No. 51134 D.

**Calcium.**

The Winning of Metallic Calcium (Verfahren zur Gewinnnung Metallischen Calciums). W. Borchers & L. Stockem. Describing experiments at the Technical High School at Aix-la-Chapelle in connection with the isolation of calcium in the electric furnace. 1200 w. Zeitschr f Elektrochemie—Oct. 2, 1902. No. 51342 G.

**Carbide.**

The Reaction Equations in the Reduction of Calcium Carbide (Die Reaktionsgleichung bei der Calciumcarbid Reduktion). Fr. von Kügelgen. A comment on the discussion of Dr. Neumann upon the production of calcium carbide. 1200 w. Zeitschr f Elektrochemie—Oct. 9, 1902. No. 51344 G.

The Reaction Equations in the Reduction of Calcium Carbide (Die Reaktionsgleichung bei der Calciumcarbid-Reduktion). Dr. B. Neumann. A review of the chemical reactions involved in the production of calcium carbide in the electric furnace. 1500 w. Zeitschr f Elektrochemie—Oct. 2, 1902. No. 51343 G.

**Chlorates.**

The Electrolytic Manufacture of Chlorates. John B. C. Kershaw. A review of early processes and the early development of this industry. 2000 w. Ill. Elec Rev, N. Y.—Oct. 4, 1902. No. 51013.

**Colloids.**

Colloids. W. R. Whitney. A study of the electrical action of colloidal suspensions or solutions. 3000 w. Trans Am Inst of Elec Engrs—June & July, 1902. No. 51136 D.

**Conduction.**

Electrolytic Conduction Without Electrodes. Carl Hering. Gives arguments supporting the belief that electrolytic conduction is possible. 2400 w. Trans Am Inst of Elec Engrs—June & July, 1902. No. 51132 D.

**Copper.**

Electrolytic Recovery of Copper from Low-Grade Ores. N. S. Keith. Gives the conditions and considerations applied in the planning and erecting of works for the electrolytic method of recovering copper from the ores of a mine near New York City. 3300 w. Trans Am Inst of Elec Engrs—June & July, 1902. No. 51135 D.

Electro-Metallurgical Problems. Alec. A. Beadle. The present article considers the problems relating to copper. 1700 w. Elec Rev, Lond.—Sept. 26, 1902. Serial. 1st part. No. 50960 A.

**Düsseldorf.**

The Industrial Applications of Electro-Chemistry at the Düsseldorf Exposition (Elektrochemie und Verwandte Gebiete auf der Ausstellung in Düsseldorf). H. Danneel. The first instalment of a complete review of the electrochemical exhibits at Düsseldorf. Serial. Part I. 4000 w. Zeitschr f Elektrochemie—Sept. 25, 1902. No. 51341 G.

**Electric Furnace.**

The Electric Furnace in Industrial Chemistry. Charles B. Jacobs. Considers the types of elctric furnace, the new products and their value in industrial chemistry, the advantages, etc. 4200 w. Trans Am Inst of Elec Engrs—June & July, 1902. No. 51131 D.

The Preheating of the Charge for the Electric Furnace (Verfahren zur Vorwärmung der Beschikung Elektrischer Oefen). A. Muriel and A. Neuburger. Showing the economy which may be effected by preheating the charge, and illustrating a form of furnace for the purpose. 1200 w. Elektrochemische Zeitschr—Oct., 1902. No. 51345 G.

The Stassano Electric Furnace (Forni Elettrici Stassano). S. Luzzati. With illustrations of the Stassano electric furnace arranged for smelting iron; also its application to steel furnaces with rotating inclined hearth on the Pernot type. 1200 w. L'Elettricita—Oct. 5, 1902. No. 51382 B.

**Electro-Chemistry.**

The Electrochemical Industries. A general review of the present condition of these industries. Storage and primary batteries and electrotyping are not considered. 5000 w. Trans Am Inst of Elec Engrs—June & July, 1902. No. 51130 D.

**Electro-Metallurgy.**

Needed Electrometallurgical Processes. The two problems referred to are a process for extracting copper from sulphide ores, and a process for treating zinc and lead ores. 900 w. Elec Rev, N. Y.—Oct. 25, 1902. No. 51271.

**Lead Refining.**

The Electrolytic Refining of Base Lead Bullion. Titus Ulke. Description of the process invented by A. G. Betts for refining lead bullion, noting its low working cost and high efficiency. 1500 w. Eng & Min Jour—Oct. 11, 1902. No. 51107.

**Nitrification.**

The Electric Nitrification of the Atmosphere. William Hand Browne, Jr. An illustrated description of the apparatus employed for the fixation of atmospheric nitrogen, and the chemical reaction under the electric arc. 3800 w. Elec Rev, N. Y. —Oct. 18, 1902. No. 51183.

**Storage Batteries.**

Deterioration of Storage Battery Plates. M. U. Schoop. Notes referring to an article by Prof. A. L. Marsh, and report of evidence gathered during ten years' practical experience. 1000 w. Elec Wld & Engr—Oct. 25, 1902. No. 51234.

**Zinc.**

Electrolytic Manufacture of Zinc. Translated from *Revue de Chimie Industrielle.* Reviews the different methods that have been utilized, the difficulties encountered, the progress made, etc. 4000 w. Sci Am Sup—Oct. 18, 1902. No. 51204.

## ELECTRO-PHYSICS.

**Alloys.**

Metallic Conduction and the Constitution of Alloys. John Alexander Mathews. Reviews what has been accomplished by various investigators of the general applicability of the solution theory to the explanation of the properties of alloys. 3800 w. Elec Wld & Engr—Oct. 4, 1902. No. 51020.

**Analogies.**

Hydraulic Analogies of Inductance and Capacity Combinations. George T. Hanchett. An explanation of the behavior of current and voltage in circuits containing inductance and capacity. Ill. 2000 w. Cent Station—Oct., 1902. No. 51034.

**Condensers.**

Graphical Method of Determining the Discharge of a Condenser Through a Variable Self-Induction. E. W. Marchant. Abstract of a paper read before the British Assn. The method is an extension of one described by Dr. Sumpner for determining the rise of current with a variable self-induction, to which a P. D. is suddenly applied. 700 w. Elec Rev, Lond.—Oct. 17, 1902. No. 51405 A.

**Induction.**

Unipolar Induction (Ueber Unipolare Induktion). H. Cahen. A review of the experiments of Hoppe, showing that the phenomena fall under similar laws, which have not yet been fully demonstrated. 5000 w. Elektrotech Zeitschr—Oct. 16, 1902. No. 51366 B.

**Radiography.**

Self Radiant Materials (Die Selbstthätig Strahlende Materie). S. Saubermann. A study of the various self-radiant substances and the phenomena which they exhibit; including the researches of Becquerel, Curie, Giesel, Schmidt, and others. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 10, 1902. No. 51325 B.

**Static Effects.**

Static Strains in High Tension Circuits, and the Protection of Apparatus. Discussion of Percy H. Thomas' paper. 5000 w. Trans Am Inst of Elec Engrs—June & July, 1902. No. 51139 D.

**Thunderstorms.**

The Theory of Thunderstorms. Concerning the remarkable experiments of Herr Schmauss, as given in the *Annalen der Physik,* which explains the phenomena as due to the picking up of an excess of negative ions by the water drops. 1,000 w. Elec Rev, Lond.—Oct. 17, 1902. No. 51-403 A.

**Transformation.**

The Theory of Current Transformation (Beitrag zur Theorie der Stromwendung). A. Rothert. An elaborate mathematical discussion, deriving formulas for computation, and accompanied with tables and diagrams for practical application. Two articles. 7500 w. Elektrotech Zeitschr—Sept. 25, Oct. 2, 1902. No. 51357 each B.

## GENERATING STATIONS.

**Alternators.**

Some Notes on Alternator Design. John Denham. Read before the Cape Town Loc. Sec. of the Inst. of Elec. Engrs. Discusses types of alternators and sets forth the superiority of polyphase plant. Also editorial. 8000 w. Elect'n, Lond.—Sept. 26, 1902. No. 50962 A.

Synchronous Commutating Machines. A. S. M'Allister. Discusses rotary converters and double-current generators, making comparison with the capacities of alternating-current generators of different number of phases. 2200 w. Am Elect'n—Oct., 1902. No. 51024.

**Armatures.**

The Armature Reaction of Alternators. C. F. Guilbert. A discussion of the diagrammatic methods that have been proposed, especially those which approach nearest to exactitude; treating the subject from the standpoint of a designing engineer. 1000 w. Elec Wld & Engr—Oct. 25, 1902. Serial. 1st part. No. 51235.

The Calculation of Armatures. Reprint of a paper presented by Prof. Luigi Pasqualini at meeting of the Italian Assn. of Elec. Engrs. Discusses the question of the design of dynamos by a series of formulæ. Also editorial comment. 1500 w. Elec Wld & Engr—Oct. 18, 1902. No. 51-196.

**Costs.**

The Cost of Energy in Electricity Supply. Alton D. Adams. A comparison of accurate figures from steam and water-power stations, showing the influence of local conditions upon the elements of cost. 2500 w. Engineering Magazine—November, 1902. No. 51392 B.

**Double Current.**

Double Current Generators and Rotary Converters. Sydney Woodfield. States the advantages of the double current generator, explaining where they will prove especially useful. 2800 w. Elec Rev, Lond.—Oct. 3, 1902. No. 51080 A.

**Dynamos.**

Leaves from a Testing Engineer's Note Book. Fred W. Davies. A brief statement of some of the faults which have occurred in dynamo-electric machines, with an explanation of them and the method adopted for their remedy. Shafts, bearings and armature cores are considered in the present article. 1500 w. Elec Engr, Lond.—Oct. 10, 1902. Serial. 1st part. No. 51160 A.

On the Specific Utilization of Materials in Dynamo Design. Prof. Sylvanus P. Thompson. Read before the British Assn. Considers this subject solely in relation to the armature. 1400 w. Elect'n, Lond.—Sept. 19, 1902. No. 50848 A.

The Making of a Dynamo. Henry A. Mavor. Abstract of a paper read at Belfast meeting of the Brit. Assn. Illustrates and describes the construction. 1600 w. Elec Rev, Lond.—Oct. 3, 1902. No. 51-082 A.

**Emden.**

The Electric Plant of the Harbor of Emden (Die Elektrischer Anlage des Emder Hafens). H. Langner. With plan of the harbor, and illustrated description of the generating station and lighting and power installations. Two articles. 7000 w. Elektrotech Zeitschr—Oct. 2, 9, 1902. No. 51359 each B.

**Generating Sets.**

Some Engines and Generators at the Düsseldorf Exposition. Illustrates and describes interesting exhibits. 2000 w. Am Elect'n—Oct., 1902. No. 51025.

**Hydro-Electric Stations.**

See Electrical Engineering, Generating Stations.

**Isolated Plant.**

Power Plant of the Cleveland Twist Drill Co. Illustrated detailed description of an interesting modern isolated plant. 2800 w. Engr, U. S. A.—Oct 1, 1902. No. 50911.

The New Power Plant for the Assabet Mills, Maynard, Mass. Illustrated description of an electric plant for driving a 5 and 6-story woolen mill, 690 x 106 ft. in plan. 3000 w. Eng Rec—Oct. 4, 1902. No. 50943.

**Newark, N. J.**

A Rebuilt and Enlarged Central Station. Illustrated description of the River Station of the United Electric Company of New Jersey, at Newark. 4000 w. Am Elect'n,—Oct., 1902. No. 51023.

**Parallel Driving.**

A few hints as to the Installation and Operation of Alternators in Parallel. Fred P. Woodbury. Helpful suggestions for the setting and operation of these machines. Ill. 3000 w. Am Elect'n—Oct., 1902. No. 51027.

**Phase Shifting.**

A New Method of Compensating for Phase Shifting in Non-Synchronous Alternators (Ein Neues Verfahren zum Kompensiren der Phasenverschiebung in Asynchronen Wechselstrommaschinen). M. Osnos. A review of the theories of Görges and Heyland, discussing them from the point of maximum economy. 2500 w. Elektrotech Zeitschr—Oct. 16, 1902. No. 51365 B.

**Regulation.**

Computation of Regulation of Alternating Current Generators. Virginius D. Moody. An explanation, illustrated by an example. 1600 w. Elec Wld & Engr —Oct. 18, 1902. No. 51198.

**Speed Regulation.**

See Mechanical Engineer, Steam Engineering.

## LIGHTING.

**Electricity and Gas.**

See Gas Works Engineering.

**Illumination.**

Light and Illumination. E. L. Elliott. An elementary explanation of the principles of photometry and their application to the problems of illumination. 4300 w. Cent Station—Oct., 1902. Serial. 1st part. No. 51033.

Some Common Faults in Exterior Illumination. S. Everett Doane. Urging the use of incandescent lamps for residential streets, side streets, and outside the more congested portions of a town or city. 1200 w. Trans Am Inst of Elec Engrs—June-July, 1902. No. 51137 D.

See Gas Works Engineering.

**Office Lighting.**

Electric Lighting in the Union Trust Company's Building, Providence, R. I. The three-wire system installed makes use of its metallic conduits to replace the neutral wire, thus saving about 40,000 feet of wire, and, it is claimed, making it impossible for fire to start from an electrical source. Ill. 1200 w. Eng Rec—Oct. 25, 1902. No. 51241.

**Train Lighting.**

See Railway Engineering, Motive Power and Equipment.

## MEASUREMENT.

**Calibration.**

A Selection for Measurement and Calibration of Alternating Apparatus (Ein Wechselspannungswähler für Mess und Aichzwecke). C. Heinke. Describing a form of variable transformer, adapted for purposes of alternating current measurement. 1800 w. Elektrotech Zeitschr—Oct. 2, 1902. No. 51361 B.

**Chronograph.**

Apparatus for Determining the Sensitiveness of the Chronograph (Uebereinen Apparat zur Empfindlich Keitsvestimmung des Chronographen). R. F. Pozdena. The time intervals are magnified mechanically, and the indications of the chronograph under test are recorded electrically upon the same plate for comparison. 2000 w. Elektrotech Zeitschr—Oct. 9, 1902. No. 51363 B.

**Instruments.**

Some Novelties in Electrical Apparatus. M. B. Field. Read at Belfast meeting of the Brit. Assn. States the objects these instruments are intended to serve. Deals with a compensated voltmeter, hot-wire wattmeter, fault indicator, and synchronizing gear. 1200 w. Elect'n, Lond—Oct. 3, 1902. No. 51077 A.

**Insulation.**

The Measurement of Insulation in Operating Continuous-Current Installations (Isolationsmessung an in Betrieb befindlichen Gleichstrom anlagen). Dr. Th. Bruger. Describing the method of employing a separate auxiliary current passing through a resistance to the earth, and measuring the extent to which the latter current is neutralized by the leakage from the main current. 1500 w. Elektrotech Zeitschr—Oct. 9, 1902. No. 51362 B.

**Measuring Device.**

A New Form of Measuring Apparatus and its Application (Ein Neues Messgerath und seine Verwendung). G. Dietze. Describing a combination of a spool wound with insulated wire and of a telephone; showing how this simple appliance may be used to detect faults and to make other measurements of current with much convenience. 3500 w. Elektrotech Zeitschr—Sept. 18, 1902. No. 51354 B.

**Polyphase.**

The Predetermination of the Fall of Pressure in Polyphase Generators (Vorausbestimung des Spannungsabfalles von Drehstrom generatoren). F. Kesselring. Describing the construction of polar diagrams from which the problem can be solved graphically. 1500 w. Elektrotech Zeitschr—Oct. 2, 1902. No. 51360 B.

**Potentiometer.**

Liquid Potentiometer; Determining Electrolytic Resistances with Direct Current Instruments. Carl Hering. Describes a liquid potentiometer and the methods of using it. 2500 w. Trans Am Inst of Elec Engrs—June and July, 1902. No. 51133 D.

**Testing.**

Testing and Other Things. N. C. Woodfin. An inquiry into the meaning and object of testing electrical apparatus, and things related to this work. 1200 w. Elec Rev, Lond—Oct. 17, 1902. Serial. 1st part. No. 51404 A.

## POWER APPLICATIONS.

**Alternating Motors.**

Alternating Current Motors. A brief description of the characteristics of these motors. 1100 w. Elec Rev, N. Y.—Oct. 18, 1902. No. 51182.

**Iron Works.**

Electrical Equipment of Antwerp Iron and Steel Works. A brief illustrated account of an interesting plant in Belgium. The extent of the electric drive and the variety of runs to which it is put is a study in the shop equipment of a modern manufactory. 1600 w. Elec Wld & Engr —Oct. 18, 1902. No. 51199.

The Antwerp Steel and Iron Works (Forges et Aciéries d'Anvers). A description of the new steel works under construction at Hoboken, near Antwerp. All the machinery, including the heavy rolls, is to be driven by electric power. 2500 w. Revue Technique—Sept. 10, 1902. No. 51307 D.

The Application of Electric Power in the Iron and Steel Industries. D. Selby-Bigge. Gives facts and figures of a practical nature collected from many sources. 3500 w. Elect'n, Lond—Oct. 3, 1902. Serial. 1st part. No. 51079 A.

The Use of Electricity in Iron and Steel Works. E. Kylberg. Read at the Düsseldorf meeting of the Iron & Steel Inst. Illustrates and describes some developments based on American practice and adapted to European requirements. 2500 w. Mech Eng—Sept. 20 and 27, 1902. 2 parts. No. 50949 each A.

**Machine Driving.**

Comparative Tests of Independent and Group Driving (Einige Prüfungs resultate des Elektrischen Gruppen und Einzel-Antriebes). H. V. Reichel. Data and results of tests made at the Pruschkowo shops of the Vienna-Warsaw railway, showing the most favorable conditions of either system. 3000 w. Glasers Annalen —Oct. 15, 1902. No. 51340 D.

**Mining Plant.**

The Electric Plant of the Boléo Mines (Installations Electriques des Mines du Boléo). E. Hoffman. A general description of the power house and distribution of the electric system at Santa Rosalia, Mexico. 2000 w. Génie Civil—Sept. 27, 1902. No. 51303 D.

**Motor Control.**

The Control of Electrical Motors in Factories. N. C. Woodfin. Discusses switches and methods of control arguing that bad systems have hindered the adoption of electric motors. 1800 w. Elec Rev, Lond—Sept. 19, 1902. No. 50853 A.

**Pumping.**

Electric Pumping Station for Sewage Disposal. Illustrated description of a fine plant at Pittsfield, Mass., which is probably the first electrically-driven pumping station for sewage disposal in the United States. 900 w. Elec Wld & Engr—Oct. 18, 1902. No. 51195.

Single-Phase Pumping Plant, Hammersmith. Illustrates and describes a plant installed to pump Thames water for condensing purposes to an elevated cast-iron tank some 700 yards distant. 2000 w. Elec Rev, Lond—Sept. 26, 1902. No. 50958 A.

**Steering.**

Electrical Steering Apparatus for Ships. George McQuilkin. An illustrated explanation of the operation of this apparatus. 2500 w. Marine Engng—Oct., 1902. No. 51012 C.

**Telpherage.**

Piscicelli Taeggi's Electric Post. William P. Digby. Brief illustrated description of a system now under the consideration of an expert committee in Rome, Italy, for the transmission of letters, newspapers and parcels along an electric aerial railway at speeds as high as 400 kilometres per hour. 1800 w. Engng—Sept. 26, 1902. No. 50972 A.

### TRANSMISSION.

**High Potential.**

Electric Power Installation Near Butte, Montana. An illustrated article describing a plant using a 50000 voltage, owned by the Missouri River Power Company. 3200 w. Sci Am Sup—Oct. 18, 1902. No. 51203.

**Long Distance.**

Long Transmission from a Steam Station for Electric Traction. Illustrates and describes a system, the main purpose of which is to operate electric car lines for a distance of 50 miles, but also furnishes current for Portsmouth, N. H., and other points. 6200 w. Elec Wld & Engr—Oct. 11, 1902. No. 51121.

Rise of Electrical Transmission. Alton D. Adams. A description of some of the largest long-distance transmissions of electrical energy in the world. 5000 w. Ill. Mines & Min—Oct., 1902. No. 51044 C.

The Swan Falls Trade Dollar Transmission. An illustrated detailed description of the transmission plant built to furnish power for the Trade Dollar Mines. The pole line is 32 miles in length. 1500 w. Jour of Elec—Oct., 1902. No. 51191 C.

**Switzerland.**

Electric Power Transmission and Supply in Switzerland. Illustrates and describes features of Swiss practice observed during a series of recent visits. 2800 w. Engr, Lond—Sept. 26, 1902. Serial. 1st part. No. 50966 A.

## GAS WORKS ENGINEERING

**Acetylene.**

How to Fit Up a Complete Acetylene Plant. F. Dye. Gives information helpful in choosing a generator, and describes the arranging and fitting of the plant. 2400 w. Plumb & Dec—Oct. 1, 1902. No. 51068 A.

**Ammonia.**

Manufacture of Sulphate of Ammonia. R. T. Stoddard. Read before the Manchester and District Junior Gas Assn. Describes, in a general way, the apparatus required and method of working. 4800 w. Jour Gas Lgt—Oct. 7, 1902. No. 51164 A.

**Analysis.**

The Analytical Valuation of Gas Coals. G. P. Lishman. Read before the Inst. of Min. Engrs. Also a critical editorial. Describes the apparatus in use at Lambton, the difficulties met and means used to remove them. Ill. 5000 w. Gas Wld—Oct. 4, 1902. No. 51073 A.

**Burners.**

Lighting Gas, and How Best to Burn It. Walter Grafton. Discusses the use of burners that will secure economy and efficiency. 1500 w. Plumb & Dec—Oct. 1, 1902. No. 51067 A.

**Carbide.**

See Electrical Engineering, Electrochemistry.

**Charging Apparatus.**

The Rapid Charging and Drawing Apparatus. J. W. Russell Wall. Read before the Eastern Co.'s Gas Mgrs. Assn. An explanation of this apparatus for charging retorts, followed by general discusion. 5200 w. Jour Gas Lgt—Sept. 23, 1902. No. 50883 A.

**Combination.**

Gas and Electricity Departments in Combination. S. Meunier. Read before the Midland Assn. of Gas Mgrs. Considers the advantages of such a combination. Also discussion. 7000 w. Jour Gas Lgt—Oct. 14, 1902. No. 51249 A.

**Earnings.**

The Earnings of a Ton of Gas Coal. C. E. Jones. The inquiry is limited to coal subjected to destructive distillation in the usual manner in the works of gas companies in the United Kingdom. 1800 w. Jour Gas Lgt—Oct. 14, 1902. No. 51247 A.

**Explosions.**

Movements of the Flame in the Explosion of Gases. Harold B. Dixon. Abstract of a paper read before the Royal Society. An account of experimental study in the field. 6000 w. Am Gas Lgt Jour—Oct. 13, 1902. No. 51119.

**Ferrocyanide.**

Ferrocyanide Manufacture at the Hague Gas-Works. Extract from a paper by Heer J. Rutten, in *Het Gas*, giving an account of a process in practical operation for the production of potassium ferrocyanide from the cyanogen in coal gas. Ill. 3800 w. Jour Gas Lgt—Sept. 30, 1902. No. 51031 A.

**Gas Heating.**

On the Use of Gas for Warming Inclosed Space. Dr. W. H. Birchmore. Discusses how best to heat with economy and success by means of illuminating gas. 5000 w. Am Gas Lgt Jour—Oct. 27, 1902. No. 51258.

Temperature and the Output of Gas-Fires: Is It Colder Before or After Christmas. An article prepared from notes drafted by E. W. T. Richmond just previous to the recent fatal accident. Considers the effect of temperature on gas consumption, giving facts in proof that it is colder during the late winter months. 5000 w. Jour Gas Lgt—Sept. 30, 1902. No. 51030 A.

The Heating Effect of Gas. W. R. Crane. Description of an improved method and apparatus for determining heating values. Ill. 4000 w. Mines & Min—Oct., 1902. No. 51045 C.

**Gasholder.**

Cable-Guided Gasholder at the Rodez Gas-Works. M. Godinet. Read before the Société Technique du Gas en France. An illustrated article describing this system and giving results of tests made. 2300 w. Jour Gas Lgt—Sept. 23, 1902. No. 50885 A.

**Gas Power.**

See Mechanical Engineering, Special Motors.

**Handling.**

Apparatus for Handling Coal and Iron (Technische Hülfsmittel zu Befördern und Lagerung von Kohlen und Eisenerzen). M. Buhle. Describing especially the appliances in use at the Charlottenburg gas works. 1500 w. Zeitschr d Ver Deutscher Ing—Sept. 27, 1902. No. 51-315 D.

**Illumination.**

Recent Improvements in the Art of Lighting and Heating (Neuerungen auf dem Gebiete des Beleuchtungs- und Beheizungswesens). Franz Walter. Discussing especially improved methods of lighting by gas, with a brief reference to heating. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 19, 26, 1902. No. 51323 each B.

See Electrical Engineering, Lighting.

**Improvements.**

Recent Improvements at the Chester Gas Works. John C. Belton. Read before the Midland Assn. of Gas Mgrs. An account of the work of modernizing the retort house, and some of the difficulties encountered. Ill. 5200 w. Jour Gas Lgt—Oct. 14, 1902. No. 51248 A.

**Incandescence.**

The Incandescent Burner in the Church. J. H. Troughton. Gives the writer's experience gained in successfully lighting some of the churches of Newmarket with incandescent burners. 1100 w. Jour Gas Lgt—Sept. 23, 1902. No. 50882 A.

Theory of the Incandescent Mantle. A. H. White and A. F. Traver. Gives data on the temperature of the flame and the mantle, the relation existing between the temperature and illumination, and discusses whether the illumination is a pure temperature effect. 5800 w. Pro Age—Oct. 15, 1902. No. 51141.

**Mains.**

Methods Employed in the Construction and Maintenance of the Massachusetts Pipe Line Gas Co.'s Mains in Boston and Vicinity. W. W. Cummings. Describes methods adopted to keep the cost within required limits. Ill. 2300 w. Eng News —Oct. 2, 1902. No. 50922.

**New Zealand.**

Incandescent Gas Lighting in Wellington, New Zealand. R. G. Howell. An explanation of the system adopted to meet keen competition with the electric light. Ill. 2700 w. Jour Gas Lgt—Sept. 23, 1902. No. 50881 A.

**Pipe Corrosion.**

See Street and Electric Railways, Stray Currents.

**Purifiers.**

The "Millbourne" and "Prins van Diesburgh" Systems of Purifiers. An illustrated description of the system devised by Herr J. J. Prins van Diesburgh, with remarks of Herr C. T. Salomons on its similarity with the Millbourne system. 1300 w. Jour Gas Lgt—Sept. 23, 1902. No. 50886 A.

**Rates.**

Gas Rates and Franchise Tax. George McLean. Read at meeting of the Am. Gas Lgt. Assn. An explanation of the laws of Iowa as bearing on these questions. 2000 w. Am Gas Lgt Jour—Oct. 20, 1902. No. 51185.

**Retorts.**

Inclined Retorts at the Vaise (Lyons) Gas-Works. M. Godinet. Read before the Société Technique du Gas en France. An illustrated description of the inclined retort-house recently installed and its working. 6300 w. Jour Gas Lgt—Sept. 23, 1902. No. 50884 A.

**Slot-Meters.**

Some of the Questions Involved in the Slot-Meter System Considered. George Helps. Read before the Midland Assn. of Gas Mgrs. Considers the service at the present time and submits certain propositions which are discussed. 8500 w. Jour Gas Lgt—Oct. 14, 1902. No. 51250 A.

**Water Gas.**

The Outlook for Carburetted Water Gas. The present article considers some of the recent working results, the departmental committee's recommendations, costs, etc. 3000 w. Gas Wld—Oct. 11, 1902. Serial. 1st part. No. 51159 A.

# INDUSTRIAL ECONOMY

**Benefit Associations.**

See Street and Electric Railways.

**Coal Trade.**

The Production, Consumption, Imports and Exports of the World's Coal Trade. Information from the annual statement prepared by the British Board of Trade. 2700 w. Ir & Coal Trds Rev—Oct. 10, 1902. No. 51165 A.

**Coke Production.**

See Mining and Metallurgy, Coal and Coke.

**Education.**

The Manchester Municipal School of Technology. An elaborately illustrated article giving a detailed description of this new building and its fine equipment. 16000 w. Engng—Oct. 10, 1902. No. 51168 A.

The Present Industrial Importance of Technical Education. Sir Philip Magnus. A review of the relation of technical education to commercial supremacy, with reference to the foresight of Germany as compared with Great Britain. 4000 w. Engineering Magazine—November, 1902. No. 51391 B.

**Germany.**

See Mining and Metallurgy, Iron and Steel.

**Labor.**

Labor Organizations in the United States. Carroll D. Wright. Reviews the development of trade-unionism in the United States, and its present standing. 4200 w. Contemporary Rev—Oct., 1902. No. 51152 D.

**Shipping Combine.**

The Atlantic Shipping Trade. Editorial discussion of the recently formed association to be known as the International Mercantile Marine Company, considering mainly its naval aspect. 3000 w. Engng—Oct. 10, 1902. No. 51169 A.

**Strike.**

Mistakes of the Anthracite Operators. Criticises their failure to conciliate public opinion, and their lack of tact. 900 w. Eng & Min Jour—Oct. 25, 1902. No. 51236.

Report to the President on the Anthracite Coal Strike. Carroll D. Wright. Considers the origin, demands, claims and complaints, wages and cost of production, etc., with suggestions. 36500 w. Bul Dept of Labor—Nov., 1902. No. 51028 D.

Settlement of the Anthracite Miners' Strike. Details of the settlement are given. 2000 w. Eng & Min Jour—Oct. 18, 1902. No. 51206.

The American Strike: Its Causes and Its Influences. Discusses the miner's wages in the United States, the quality of the coal, the influence on British prices, and the tariff. 3800 w. Ir & Coal Trds Rev—Oct. 10, 1902. No. 51166 A.

**Wages.**

The False Economy of a Low Wage Rate. Percy Longmuir. Showing the inefficiency of cheap labor, and the wastefulness of ill-nourished workers, as compared with the productiveness of higher paid workmen. 3500 w. Engineering Magazine—November, 1902. No. 51396 B.

# MARINE AND NAVAL ENGINEERING

**Cruisers.**

Launch of the Des Moines. Illustration with particulars relating to the construction and equipment of this cruiser. 2000 w. Naut Gaz—Sept. 25, 1902. No. 50841.

The French Armored Cruiser Kleber. Illustrated description of one of three 7700 tons cruisers of a novel type. 1000 w. Engr, Lond.—Oct. 3, 1902. No. 51090 A.

The Latest British Armored Cruiser "Good Hope." Illustration and interesting comparisons of this first of a class of fast and powerful cruisers, with earlier vessels. 1000 w. Sci Am—Oct. 18, 1902. No. 51200.

**Destroyers.**

U. S. Torpedo-Boat Destroyers Truxton, Whipple and Worden. An illustrated description of one of these three identical boats, the armament, and report of trials. 1400 w. Marine Engng—Oct. 1902. No. 51006 C.

**Electric Steering.**

See Electrical Engineering, Power Applications.

**Firing.**

Firing on Ocean Steamships. Lawrence Irwell. Remarks on the service, class of men, their accommodations at sea, and customs, especially on English ships. 3000 w. Marine Rev—Sept. 25, 1902. No. 50-833.

**Fog Signals.**

Experiments at St. Catherine's with Fog Signals. H. C. Fyfe. An illustrated article giving an account of a series of tests mainly devoted to comparisons of efficiency between the siren principle and the reed principle of producing sound. 900 w. Sci Am—Oct. 11, 1902. No. 51054.

**Gunboats.**

The New American-Built Mexican Gunboats. Illustrated description. 900 w. Naut Gaz—Sept. 25, 1902. No. 50842.

**Life-Boats.**

New Life-Saving Boat in Norway. Brief description of a new lifeboat which has just been tried with satisfactory results. 450 w. U S Cons Repts, No. 1472—Oct. 18, 1902. No. 51150 D.

The Dickenson Improved Life Boat. Illustrated description of a novel boat constructed of metallic sheets, self-bailing and self-righting. 700 w. Am Shipbuilder—Oct. 9, 1902. No. 51049.

**Liners.**

The Launch of the White Star Liner "Cedric." Harold J. Shepstone. Illustrations with brief description of this vessel the largest ship ever built. 900 w. Sci Am Sup—Oct. 11, 1902. No. 51055.

The New Atlantic Liners. Concerning the new fast vessels to be built by the Cunard Company, discussing the vessels already in service which have at different times lowered the record across the Atlantic. 3700 w. Engr, Lond.—Oct. 17, 1902. No. 51421 A.

**Shipping Combine.**

See Industrial Economics.

**Stability.**

Stability of an Oil-Tank Steamer. P. F. Walker. Investigations of the effect of liquids in a ship when the containing tanks or compartments are not completely filled. 2500 w. Marine Engng—Oct., 1902. No. 51007 C.

**Steamboat.**

New Steamboat Maryland. Illustration and description of a fine passenger vessel just completed for service on Chesapeake Bay. 1600 w. Naut Gaz—Oct. 2, 1902. No. 50996.

**Tail-Shafts.**

Suggestions as to the Prevention of Corrosion of Tail-End Shafts. John Boddy. Read before the Inst. of Marine Engrs. Describes appliances used for the prevention of corrosion, and a system of lubricating such shafts, giving results attained. Also discussion. 2500 w. Marine Engng—Oct., 1902. Serial. 1st part. No. 51009 C.

**Tender.**

United States Lighthouse Tender Magnolia. Illustrated description of a new vessel to be used in the Gulf of Mexico and lower Mississippi. A departure in design has been made to meet the conditions of that climate. 1100 w. Marine Rev—Oct. 23, 1902. No. 51257.

**Testing Tank.**

The North German Lloyd Testing Tank at Bremerhaven (Die Schiffbau-Technische Versuchsstation des Norddeutschen Lloyd in Bremerhaven). A. Schromm. With views of the tank and model rooms and diagrams of the recording apparatus. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—Oct. 4, 1902. No. 51369 B.

**U. S. Navy.**

Report on Naval Construction. Abstract of the report of Admiral F. T. Bowles concerning work on new vessels, repairs, improvement in plants, etc. 2000 w. Ir Age—Oct. 16, 1902. No. 51142.

# MECHANICAL ENGINEERING

## AUTOMOBILES.

**Berlin Exhibition.**

The German Automobile Exposition at Berlin, 1902 (Die Deutsche Automobil-Ausstellung zu Berlin, 1902). With illustrations of the various motor cycles and automobiles shown at the recent exhibition. Two articles, 3000 w. Glasers Annalen—Sept, 15, Oct. 1, 1902. No. 51338 each D.

**Electric Cars.**

Electrically-Propelled Motor Cars. Illustrates and describes some of the vehicles of the British Electromobile Company, and discusses some of the advantages and disadvantages of electric cars. 3000 w. Elect'n, Lond—Sept. 19, 1902. No. 50847 A.

**Fore-Carriage.**

A Novel Automobile Fore-Carriage. From *La Locomotion.* An illustrated description of a novel mechanism which transforms the usual horse-drawn vehicles into motor machines, and is also used on automobiles giving great facility in steering and operation. 3800 w. Sci Am Sup—Oct. 11, 1902. No. 51056.

**French Designs.**

The Automobile in 1902 (L'Automobile en 1902). G. Lavergne. The first of a series of articles discussing in detail the latest improved forms of French automobiles. The first instalment treats of the elements of the internal combustion motor for automobiles. 6000 w. Rev Gen des Sciences—Sept. 15, 1902. No. 51380 D.

**Generators.**

A Home Made Generator and Pilot Light. W. P. Haines. Illustrates and describes a successful arrangement of auxiliary gasoline burner for steam automobiles, devised by the writer and made at small cost. 2000 w. Horseless Age—Oct. 8, 1902. No. 51036.

**Hill-Climbing.**

The Chateau-Thierry Hill Climb. An illustrated account of very successful trials. 1000 w. Autocar—Oct. 4, 1902. No. 51066 A.

The Gaillon Hill-Climbing Trials. An illustrated account with report of results. 1800 w. Autocar—Oct. 18, 1902. No. 51-413 A.

The Gaillon Hill-Climbing Trials. An illustrated account. Also of the Mont Ventoux climb. 2800 w. Autocar—Sept. 27, 1902. No. 50953 A.

**Ignition.**

Alternating Current System of Ignition. Albert L. Clough. Remarks on Mr. Bramwell's proposal for this system of ignition, with brief discussion of other devices. 1000 w. Horseless Age—Oct. 22, 1902. No. 51266.

Charging Ignition Accumulator Cells. Explains methods of charging from a private plant, public supply, and when neither of these sources is available. 3000 w. Auto Jour—Oct. 18, 1902. No. 51411 A.

**Military Vehicles.**

The War Office Committee's Report on Military Self-Propelled Lurries. Extracts from this report, with remarks, 3300 w. Auto Jour—Sept. 20, 1902. No. 50857 A.

**Motor Cars.**

Oil Motor Cars for 1902. C. C. Longridge. Considers points in the principles of construction of petrol cars as at present manufactured. Ill. 21500 w. Inst of Mech Engrs—Oct. 17, 1902. No. 51427 D.

The Maudslay 20 H. P. Car. Begins an illustrated detailed description of a car containing new features. 900 w. Autocar —Oct. 18, 1902. Serial. 1st part. No. 51412 A.

**Petrol Cars.**

The Ariel Petrol Cars. The first of a series of illustrated articles describing interesting vehicles made in Birmingham, England. 900 w. Auto Jour—Sept. 20, 1902. Serial. 1st part. No. 50855 A.

The New 16 h. p. De Dietrich Car. An illustrated description of new cars built under Turcat-Méry patents. 1200 w. Autocar—Oct. 4, 1902. No. 51064 A.

**Petrol Motors.**

Cylinder Lubrication in Petrol Motors. C. C. Longridge. Discusses the maximum working temperature of the cylinder walls and the maximum stability of the oil under heat. 1400 w. Autocar—Oct. 4, 1902. No. 51065 A.

**Pleasure Vehicles.**

The Motor Manufacturing Company's Cars. Illustrates and describes three recently built types, of 8, 10, and 20 h. p. respectively. 1800 w. Auto Jour—Oct. 11, 1902. No. 51156 A.

**Racing Car.**

Peerless Racing Car. Illustrated detailed description of the 1903 model. 2200 w. Auto & Motor Rev—Oct. 11, 1902. No. 51050.

The Truffault Racer. From *La Locomotion.* Brief illustrated description of an interesting experimental machine. 500 w. Sci Am—Oct. 4, 1902. No. 50940.

**Reliability Run.**

Boston Reliability Run. Gives itinerary and road description of the New York-Boston reliability run which begins on Oct. 9, 1902. 2800 w. Auto Topics—Oct. 4, 1902. No. 50917.

Conclusions on the Reliability Contest. Albert L. Clough. Remarks on the New York-Boston run, unreliable parts, lubrication, etc. 1500 w. Horseless Age—Oct. 22, 1902. No. 51265.

Impressions Gained from the Run—Features of Construction. Hugh D. Meier. Remarks on Springs, axles, wheels and tires, chains and transmissions, etc. 2200 w. Horseless Age—Oct. 22, 1902. No. 51268.

New York-Boston Reliability Run. An illustrated account of the recent test run. 3700 w. Auto Topics—Oct. 18, 1902. No. 51151.

The A. C. A. 500 Mile Reliability Run from New York to Boston and Return. An illustrated general report. 9000 w. Horseless Age—Oct. 15, 1902. No. 51180.

The Reliability Trial from a Technical Point of View. The present article gives illustrated brief descriptions of the competing vehicles, general criticisms, etc. 7300 w. Auto Jour—Sept. 20, 1902. Serial. 1st part. No. 50856 A.

The 650 Miles Reliability Trials. An explanation of how the marks were lost on the road, as far as now known; speeds and times accomplished on the test hills; with observations on the trials, by Henry Sturmey. 7000 w. Autocar—Sept. 20, 1902. No. 50858 A.

**Repairs.**

The Item of Repairs. Dr. Daniel Longaker. Remarks on points in design that need attention. 1800 w. Horseless Age—Oct. 22, 1902. No. 51267.

**Rules.**

Reliability Trial Rules. Gives tabulated results showing the effect of a system of rules based upon speed, number of passengers, fuel consumption and cost of vehicle. Also editorial and report of the revised official marks and the judges' awards. 4400 w. Auto Jour—Oct. 11, 1902. No. 51157 A.

**Touring Car.**

The Rochet Touring Car. Illustrates and describes the latest type of touring car. It has a gas motor, and the power transmission and action of gears is explained. 1500 w. Autocar—Sept. 27, 1902. No. 50952 A.

**Tires.**

Tyre Manipulation. Illustrated instructions referring to tyres having thickened edges. 1700 w. Autocar—Sept. 20, 1902. No. 50859 A.

**Traction.**

Traction of Road Vehicles. Information from a committee report presented at the Belfast meeting of the Brit. Assn. on the resistance of road vehicles to traction. Illustrates the apparatus by which investigations were carried on. 3500 w. Engng—Oct. 3, 1902. No. 51092 A.

**Voiturette.**

The Swift Voiturette. Illustrates and describes the distinctive features of this vehicle. Its weight is 8½ cwt. 2500 w. Auto Jour—Oct. 18, 1902. No. 51410 A.

## HYDRAULICS.

**Electric Pumping.**

See Electrical Engineering, Power Applications.

**Flow.**

The Flow of Water in Wood Pipes. Discussion of paper by Theron A. Noble. 4300 w. Pro Am Soc of Civ Engrs—Oct., 1902. No. 51255 E.

**Hydraulic Power.**

The "White Coal" Congress (Le Congrès de la "Houille Blanche"). J. A. Montpellier. A report of the convention recently held in France for the discussion of the development of the hydraulic power of the French Alps. Serial. Part I. 3000 w. L'Electricien—Oct. 11, 1902. No. 51384 B.

**Hydro-Electric.**

Electrical Supply from Water Power. Alton D. Adams. Points out the extent to which small water powers, and parts of larger ones, have been applied to systems of electrical supply in Massachusetts. 1000 w. Elec Wld & Engr—Oct. 4, 1902. No. 51019.

Progress on Power Station No. 2 of the Niagara Falls Power Company. Photographs showing the progress of this work, which will soon be ready for operation, with explanatory notes. 800 w. Eng News—Oct. 2, 1902. No. 50920.

The Big Bend Tunnel for Power Development. Franklin Riffle. Gives the history of this tunnel which was a disastrous mining failure, and an account of its recent utilization for power development, in which it promises great commercial success. 1200 w. Sci Am—Oct. 11, 1902. No. 51053.

The Sault Ste. Marie Water Power. Frank C. Perkins. Illustrations showing the power canal and power house during construction, with interesting information concerning this great work. 1700 w. Elec Wld & Engr—Sept. 27, 1902. No. 50843.

**Plumbing.**

Plumbing in the Flat Iron Building, New York. Illustrated description of the work in a building of triangular plan, rising 285 feet above the street and exposed on its three sides. 2500 w. Eng Rec—Oct. 4, 1902. No. 50948.

The Theory and Practice of Plumbing. Charles L. Hubbard. The first of a series of illustrated articles designed to be helpful to both the apprentice and skilled mechanic. 1000 w. Dom Engng—Oct. 25, 1902. Serial. 1st part. No. 51259 C.

**Pumps.**

The Pumping of Slimes and Sands. L. J. Charles. Illustrations of various sand pumping devices, with figures in regard to the capacities, power used and limitations or conditions, under which each gives the best satisfaction. 1200 w. Min Rept—Oct. 9, 1902. Serial. 1st part. No. 51104.

The Steam Pumping Plant of the Charlottenburg Waterworks (Die Dampfpumpanlage für das Förderwerk der Charlottenburger Wasserwerk). E. Alberts. Illustrated description of compound horizontal pumping engines, with data and results of tests. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 20, 1902. No. 51313 D.

## MACHINE WORKS AND FOUNDRIES.

**Beam Bending.**

Beam Bending Machine. E. C. Thulin. An illustrated description of a machine used in the construction of small cars, but applicable to other uses. 700 w. Am Mach—Oct. 23, 1902. No. 51274.

**Brazing.**

Brazing Cast Iron by a New Process. Illustrated description of this cast-iron brazing process patented by Friedrich Pich. 1000 w. Eng News—Oct. 16, 1902. No. 51219.

**Calipers.**

Evolution of the Spring Caliper. E. R. Markham. Brief review of the improvements made and the growth of the business. Ill. 1100 w. Am Mach—Oct. 2, 1902. No. 50900.

**Castings.**

Casting Car Journal Bearings. C. Vickers. Detailed description of manner of casting car brasses. 1500 w. Am Mach—Oct. 2, 1902. No. 50901.

**Cranes.**

Anchors for Crane Chains—Casting Hoisting Drums. G. E. Flanagan. Illustrates the right and wrong methods and explains the advantages of methods recommended. 1400 w. Am Mach—Oct. 23, 1902. No. 51276.

**Cupolas.**

Chemistry and Cupola Practice. Edward Kirk. On the importance of properly understanding melting, and the troubles due to improper melting. 900 w. Foundry—Oct., 1902. No. 50870.

**Designing.**

Careless Designing. Peter H. Bullock. Remarks on mistakes in designing. 800 w. Am Mach—Oct. 2, 1902. No. 50899.

**Drawing Room.**

The Lodge & Shipley Drawing Room. Illustrated description of a well arranged office having features of interest. 1500 w. Mach, N Y—Oct., 1902. No. 50865.

**Electric Driving.**

See Electrical Engineering, Power Applications.

**Foundry.**

The New Westinghouse Foundry at Trafford City, Pa. Illustrated description of an industrial town near Pittsburg, and of the buildings erected for a large foundry. 1500 w. Eng Rec—Oct. 4, 1902. No. 50947.

**Grinding.**

Collection and Removal of Refuse from Grinding and Polishing Machines. A. W. Bayard. Discusses the reasons why such refuse should be removed and the most effective mode of accomplishing the desired end. 1500 w. Ir Trd Rev—Oct. 9, 1902. No. 51037.

The Norton Grinding Machine. Illustrated description of a machine made in Worcester, Mass., with report of the work done by it, its operation, time performance, etc. 3500 w. Engng—Oct. 17, 1902. No. 51422 A.

**Indexing.**

Fractional Indexing. C. E. De Puy. Gives an index table and an explanation of the writer's method. 1200 w. Am Mach—Oct. 23, 1902. No. 51275.

**Keys.**

Strength and Proportion of Keys. Frank P. Kleinhans. Gives method of calculating. 800 w. Am Mach—Oct. 9, 1902. No. 51041.

**Ladles.**

Slag and Metal Ladles. Illustrates and describes various recent types. 3000 w. Ir & Coal Trds Rev—Oct. 3, 1902. Serial. 1st part. No. 51085 A.

**Lubrication.**

Something About Oil Grooves. Charles J. Mason. Describes a system efficient in all particulars, and considers the supply of oil to the journals and bearings of a horizontal shaft. Ill. 2200 w. Engr, U S A—Oct. 1, 1902. Serial. 1st part. No. 50912.

**Machine Tools.**

Machine Tool Progress. Charles E. Hadley. The first of a series of illustrated articles dealing with this subject, and briefly reviewing the history of standard tools. 1500 w. Elec Rev, N Y—Oct. 25, 1902. Serial. 1st part. No. 51273.

**Patterns.**

The Difference Between Good and Bad Pattern Work. Gives the qualifications of a good pattern maker, and notes some of the failures of a poor one. Ill. 1500 w. Am Mach—Oct. 2, 1902. No. 50898.

**Pipes.**

Molding Pipes Without Patterns. Francis W. Shaw. Explains in detail a method which enables molding operations to be commenced immediately. Ill. 900 w. Am Mach—Oct. 2, 1902. No. 50897.

**Shops.**

Early Machine Shops and Mechanics. Historical notes on the development of the machine shop during the early part of the nineteenth century. Ill. 4800 w. Mach, N Y—Oct., 1902. No. 50866.

Shop Construction. Oscar E. Perrigo. The first of a series of illustrated articles upon the design and construction of machine shops, with hints upon the arrangement of tools, and the management. 2200 w. Mach, N Y—Oct., 1902. Serial. 1st part. No. 50864.

**Wastes.**

Workshop Wastes—Metals. W. J. May. Some suggestions for utilizing the metal of the scrap heap. 1200 w. Prac Engr—Oct. 3, 1902. No. 51060 A.

## MATERIALS OF CONSTRUCTION.

**Alloys.**

See Electrical Engineering, Electro-Physics.

**Balata.**

Balata and Its Employment. Editorial on this material, which is so generally confused with gutta percha and rubber that statistics are not reliable. 2000 w. Engng—Oct. 17, 1902. No. 51425 A.

**Elasticity.**

The Laws of Elastic Extension (Zur Gesetzmässigkeit der Elastichen Dehnungen). W. Schüle. A review of recent experimental results, with curves of tests and comparisons between computed and experimental values. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 4, 1902. No. 51-317 D.

**Expansion.**

The Expansion of Iron, Copper, Aluminum, Brass, and Bronze at High Temperatures (Ueber die Ausdehnung von Eisen, Kupfer, Aluminum, Messing, und Bronze in Hoher Temperatur). W. Dittenberger. Results of recent determinations of expansion coefficients made at the Reichsanstalt at Berlin. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 11, 1902. No. 51320 D.

**Pig Iron.**

Buying Pig Iron and Coke. W. G. Scott. Discusses the proper method of buying, and gives the J. J. Case Threshing Machine Co.'s specifications for foundry pig iron and for coke. 4200 w. Foundry —Oct., 1902. No. 50869.

**Resistance.**

The Conditions of Elasticity and Resistance of Various Kinds of Iron (Die Elastizitäts- und Festigkeitseigenschaften der Eisensorten). C. Bach. A study of the relation of elasticity and resistance of materials to temperature, with tables and diagrams of experimental results. 2000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Oct. 11, 1902. No. 51321 D.

**Structure.**

The Internal Structure of Iron and Steel with Special Reference to Defective Material. S. A. Houghton. Shows that chemical analysis is not all that is needed in determining the quality of metals, and that an examination of the structure is of great importance. Considers the causes of failure, etc. Ill. 8300 w. Metallographist—Oct., 1902. No. 51124 F.

## MEASUREMENT.

**Calorimetry.**

The Calorific Power of Coals (Sur le Pouvoir Calorifique de la Houille). M. Goutal. Giving a simplified formula for computing the calorific power of a given coal from its chemical composition. 700 w. Comptes Rendus—Sept. 22, 1902. No. 51376 D.

**Indicator.**

Pressure Indicator. Illustrates and describes the interesting features of an instrument invented by J. E. Petavel, with records showing how it works. 1300 w. Engr, Lond—Oct. 10, 1902. No. 51175 A.

**Tanks.**

The Content and Surface of Tanks (Inhalte und Oberflächen von Gefässen). M. Grellert. Discussing the method of computing tanks of various forms so that the surface may be a minimum and the content a maximum. 2500 w. Gesundheits-Ingenieur—Sept. 15, 1902. No. 51-371 B.

## POWER AND TRANSMISSION.

**Compressed Air.**

A King-Riedler Air Compressor of 1,000 Horse-Power. Illustrated detailed description. 1200 w. Am Mach—Oct. 16, 1902. No. 51214.

The Daw Air-Compressor. Illustrates and describes these machines and their operation. The object of the invention is the economical production at speeds hitherto thought unattainable, securing greater output from smaller machines. 2400 w. Engng—Sept. 26, 1902. No. 50969 A.

**Conveying Machinery.**

Crushing, Preparing, and Conveying Machinery (Müllerei, Hartzerkleinerung, und Mechanische Aufbereitung nebst Transport und Umladevorrichtungen). H. Rasch. Reviewing especially the devices shown at the Düsseldorf exposition. Serial. Part I. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 11, 1902. No. 51-319 D.

See Gas Works Engineering.

**Elevators.**

A High Drop Test of an Elevator Safety Air Cushion. An account of an interesting test made in the Philadelphia City Hall tower. The passenger elevator, weighing 2,500 lbs., was allowed to drop from the top of the shaft, a free fall of 290 feet before entering the air cushion. 2000 w. Eng News—Oct. 9, 1902. No. 51098.

**Shafting.**

The Capacity of Shafting. A. G. Holman. Gives a graphic representation of the usual formula for horse-power laid out on a logarithmic scale, with rules for its use. 600 w. Power—Oct., 1902. No. 50878 C.

**Telpherage.**

See Electrical Engineering, Power Applications.

## SPECIAL MOTORS.

**Alcohol.**

Alcohol Power Generating Set (Groupe Electrogène à l'Alcool). MM. Sartiaux & Cossman. Describing the convenient arrangement of alcohol motor and dynamo used for charging accumulators for operating winches at the small stations of the Northern Railway of France. 2000 w. Rev Gen des Chem de Fer—Sept., 1902. No. 51377 H.

**Binary Engines.**

The Binary Steam Engine (Die Abwärme-Dampfmaschine). H. Behrend. A discussion of the thermodynamic principles involved in the design of binary vapor engines with curves of specific volumes of various substances available for use in the second cylinder. 1500 w. Zeitschr d Ver Deutscher Ing—Oct. 4, 1902. No. 51318 D.

**Diesel Motor.**

The Diesel Oil Engine. Arnold G. Hansard. Illustrates and describes the principal characteristics of this engine and discusses the cost of working. 1500 w. Elec Times—Oct. 16, 1902. Serial. 1st part. No. 51298 A.

The New Diesel Oil Engine. An illustrated description of the improved engine which is capable of consuming petroleum refuse, so that it may be operated on the crudest of oils. 2300 w. Am Elect'n—Oct., 1902. No. 51026.

**Gas Engines.**

A Preliminary Note on Gas-Engine Explosions. H. E. Wimperis. Read before the British Assn. An application of the variable specific heat hypothesis to the classical experiments made by Mr. Dugald Clerk. An important contribution to the thermodynamics of heat engines, and of interest to designers of gas engines. 1100 w. Engng—Oct. 10, 1902. No. 51172 A.

Avoiding Trouble with a Gas Engine. H. H. Kelley. On the care and attention needed. 1600 w. Engr, U S A—Oct. 1, 1902. No. 50914.

Design of Gas Engines. James Dunlop. The first of a series of articles on the operation of gas engines, and the design of the various parts. 1400 w. Mech Engr—Oct. 4, 1902. Serial. 1st part. No. 51071 A.

500 H.-P. Double-Acting Körting Gas Engine and Blowing Cylinder. Illustrated description of an engine exhibited at Düsseldorf. 350 w. Plate. Engng—Sept. 26, 1902. No. 50970 A.

Gas Engines for High-Pressure Fire Service. J. R. Bibbins. A short description of the engines to be installed in the city of Philadelphia, the principal reasons for their adoption and their inherent qualifications for the required duty. Ill. 3500 w. Ins Engng—Sept., 1902. No. 50919 C.

Power Gas and Producer Gas Installations Working with Pressure and with Exhaust. Summary of a paper by Herr Johann Korting, published in the *Journal für Gasbeleuchtung.* Reviews the work of investigators leading to the use of producer gas, and describes a plant dispensing with the steam boiler. 1800 w. Gas Wld—Sept. 27, 1902. No. 50955 A.

The Commercial Development of the Gas Engine. Reviews the work of the early inventors and progress to the present, beginning an illustrated description of the Westinghouse engine. 4000 w. Mech Engr—Oct. 11, 1902. Serial. 1st part. No. 51158 A.

The Determination of Fuel Consumption in Gas Engines (Evaluation de la Consommation dans les Moteurs à Gaz). J. Deschamps. A discussion of the varying methods of recording the performance of gas engines, with suggestions as to the unifying of methods in order to render results comparable. 5000 w. Mem Soc Ing Civ de France—Aug., 1902. No. 51328 G.

The New Niel Motor (Le Nouveau Moteur Niel). A. Moreau. A fully detailed description of the improved gas engine of the Niel Company, with data and results of tests showing more than 25 per cent. thermal efficiency. 8000 w. 2 plates. Mem Soc Ing Civ de France—Aug., 1902. No. 51330 G.

**Gasoline Engines.**

Loss of Power in Gasoline Engines. Albert Stritmatter. Considers causes of decrease in power, and the remedies. 2000 w. Am Mfr—Oct. 9, 1902. No. 51105.

**Gas Power.**

Gas Power Station for an Electric Hoisting Machine (Gas-Kraft Primäranlage für eine elektrische Fördermaschine). Illustrating a combined generating set of 100 h. p. gas engine and dynamo in connection with a Pintsch gas producer for driving an electric mine hoist. 1200 w. Glückauf—Oct. 11, 1902. No. 51350 B.

The Pintsch Power Gas Plant. Illustrates and describes a gas plant supplying two 80-h. p. Otto cycle engines in which no gas-holder is employed. 1800 w. Ir & Coal Trds Rev—Oct. 17. 1902. No. 51-426 A.

**Internal Combustion.**

Progress in Internal Combustion Engines. W. H. Booth. A review of recent advances in economy, reliability and range of adaptation, showing the advantages of high compression and the progress in the utilization of waste furnace gases. 3000 w. Engineering Magazine—November, 1902. No. 51395 B.

## STEAM ENGINEERING.

**Binary Engines.**

See Mechanical Engineering, Special Motors.

**Boilers.**

Boilers: Old and New. Louis F. Pearson. Read before the Inst. of Heat. & Ven. Engrs. (England). Deals with hot water boilers only, giving illustrations of English boilers and discussing their merits. Also general discussion. 5000 w. Plumb & Dec—Oct. 1, 1902. No. 51070 A.

Riveted Joints for Steam Boilers. W. H. Wakeman. States facts showing the only safe way is to determine the strength of every joint, and endeavors to give plain rules for doing this. 1600 w. Elec., N Y —Oct. 29, 1902. Serial. 1st part. No. 51288.

Steam Boiler Settings and Appurtenances. C. F. Swingle. The present article considers walls and furnaces, fittings and safety appliances, domes and mud drums, feed pipes, etc. Ill. 3500 w. Steam Engng—Oct. 10, 1902. Serial. 1st part. No. 51270.

The Solignac Boiler. W. H. Booth. Read at Belfast meeting of the Brit. Assn. An account of tests made of this water-tube boiler, with description of its important features. 2900 w. Mech Engr,—Oct. 4, 1902. No. 51072 A.

**Calorimetry.**

See Mechanical Engineering, Measurement.

**Condensers.**

Surface Condensers. C. G. Robbins. Discusses the formulas of J. M. Whitham and C. P. Poole, and illustrates their application by an example. 1800 w. Marine Engng—Oct., 1902. No. 51008 C.

The Cooling of Condensing Water. Gives results of experience and observation in respect to the cooling of injection water for condensing and other purposes, indicating points that should be considered. 1500 w. Prac Engr—Sept. 26, 1902. No. 50954 A.

Water Cooling Appliances for Condensers (Kühlwasserakkumulator für Kondensatoren). F. J. Weiss. A review of the various methods of cooling condenser water for repeated use. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 27, 1902. No. 51314 D.

**Condenser Tubes.**

Condenser Tube Electrolysis and Corrosion. James F. Hobart. An explanation of what takes place and suggestions of remedies. Ill. 2500 w. Power—Nov., 1902. No. 51299 C.

**Corrosion.**

Corrosion of Boilers by Magnesium Chloride. Editorial review of a paper by H. Ost in the *Chemiker Zeitung*, giving an account of experimental investigations. 900 w. Engng—Oct. 10, 1902. No. 51171 A.

**Düsseldorf.**

Steam Engines at the Düsseldorf Exposition (Les Machines à Vapeur à l'Exposition de Düsseldorf). P. Dujardin. A general review of the engines exhibited at Düsseldorf, with tabular view of the whole. 2500 w. 1 plate. Génie Civil—Sept. 20, 1902. No. 51302 D.

**Feed-Water.**

Comparative Methods of Heating Feed Water. Presents the heat balances and cost figures for six of the systems in common use, arranged for comparison. 3500 w. Power—Nov., 1902. No. 51401 C.

Feed Waters and Their Action on Boilers. Clifford A. Bowen. Considers the impurities contained in water and their effect on boiler plates; the methods of purification, tests, etc. 4000 w. Elec Rev, Lond.—Oct. 3 and 17, 1902. Serial. 2 parts. No. 51402 each A.

**Firing.**

See Marine Engineering.

**Flywheels.**

Safe Speeds for Flywheels. William H. Boehm. From the *Monthly Bulletin* of the Fidelity and Casualty Co. Gives solution of the problem of finding the speed at which disruption will occur. 1200 w. Eng News—Oct. 2, 1902. No. 50921.

**Fuel.**

The Relative Values of Fuel. Gives the results of Prof. William Kent's experiments, as given in "Steam Boiler Economy." Also results obtained by other experimenters, with remarks. 1300 w. Dom Engng—Oct. 25, 1902. No. 51260 C.

**Generating Sets.**

See Electrical Engineering, Generating Stations.

**Lubrication.**

Oil Systems. H. D. Drew. Illustrates and describes a gravity system installed in a large power plant. 1700 w. Power—Nov., 1902. No. 51400 C.

The Use of Low Grade Oil and its Effect upon the Air Discharged from a Condenser. R. S. Carter. States an experience in tunnel work which caused the air to become so impure as to affect the workers, which was traced to the use of poor oil. 600 w. Compressed Air—Oct., 1902. No. 51231.

**Oil Fuel.**

Oil Burning. Frank H. Bates. Reviews the Billow system of oil burning. The present paper illustrates and describes the methods and apparatus used for the preparation and delivery of oil to the burners. 900 w. Jour of Elec—Oct., 1902. Serial. 1st part. No. 51192 C.

**Pipes.**

Steam Pipe Sizes. Charles L. Hubbard. Gives methods of computing pipe sizes to meet the usual requirements in low and high pressure work. 2500 w. Engr, U. S. A.—Oct. 15, 1902. No. 51228.

**Piston Valves.**

Some Notes on Piston Valves. F. A. Haughton. Calls attention to peculiarities inherent in certain types. Diagrams and indicator cards with general discussion. 4200 w. Pro Richmond Ry Club—Sept. 11, 1902. No. 50918.

**Power Plants.**

The Designing of Steam Power Plants. Walter C. Kerr. Aims to point out some of the ways and means by which the engineer may deal first with the general and then with the specific questions involved, and to indicate something of the service that may be expected of the engineer in making determinations underlying large expenditures. 3600 w. St Ry Jour—Oct. 4, 1902. No. 50985 D.

**Prime Movers.**

Prime Movers and Their Ailments. Editorial review of the report of Mr. Michael Longridge of failures and accidents and their causes. 2000 w. Engng—Oct. 17, 1902. No. 51424 A.

**Rotary Engines.**

A Novel Rotary Engine. Illustrates and describes a rotary steam engine patented by Oliver C. Jones. 900 w. Sci Am—Oct. 25, 1902. No. 51293.

The Hult Rotary Steam Engine. An illustrated description of the construction and method of working. 2000 w. Engng—Oct. 17, 1902. No. 51423 A.

**Scale.**

Boiler Scale and the Transmission of Heat. Showing that scale of ordinary thickness is objectionable because it raises the temperature of the boiler plate, rather than because it cuts down the efficiency of the boiler. 3000 w. Locomotive—Sept., 1902. No. 51143.

**Smoke.**

Smoke Abolition. T. T. Parker. Discusses points in a recent article by W. H. Booth, and suggests inexpensive changes that give good results in small plants. Ill. 1500 w. Am Mach—Oct. 16, 1902. No. 51215.

Smoke and Its Abatement in Large Cities. C. H. Benjamin. Considers the nature of soft coal smoke and the devices which cause complete combustion and so prevent smoke. Ill. 1800 w. Tech Or—Sept., 1902. No. 51127 E.

The Prevention of Smoke. John S. Raworth. Abstract of a paper read at Belfast meeting of the Brit. Assn. Concerning the Wilson process, which consists in squirting a mixture of air and nitrate of soda solution on the fire. Also report of a series of tests. 1400 w. Elect'n, Lond—Sept. 26, 1902. No. 50963 A.

The Prevention of the Smoke Nuisance and Waste of Fuel (Rauchplage und Breunstoffverschwendung und deren Verhütung). A study of the chemical reactions involved in the smokeless combustion of fuel, discussing the practicability of its successful accomplishment. 3000 w. Gesundheits-Ingenieur—Sept. 30, 1902. No. 51372 B.

The Smokeless Combustion of Bituminous Fuels. W. H. Booth. Read at Belfast meeting of the Brit. Assn. A study of the conditions required for smokeless combustion. 2700 w. Elec Rev, Lond.—Sept. 26, 1902. No. 50961 A.

The Suppression of Smoke in Steam Plants Using Bituminous Coal. Albert A. Cary. Discusses the theory of smoke suppression, various methods of firing and furnace developments, and gives short descriptions of some special hand fired furnaces designed to suppress smoke and promote fuel economy. 4000 w. Ir Age—Oct. 2, 1902. Serial. 1st part. No. 50861.

**Speed Regulation.**

Governors and Governing Mechanism. Herbert Reed Hall. Describes various forms of governors and considers the essential qualities that a governor should possess. 1800 w. Prac Engr—Oct. 3, 1902. Serial. 1st part. No. 51059 A.

Hand Adjustment of the Governors of Steam Plants in Electric Light Stations. J. H. Dales. Explains what is meant by hand adjustment, considering only high-speed, spring-load centrifugal governors in studying the limit of possibilities. 1500 w. Elect'n, Lond—Oct. 3, 1902. No. 51078 A.

Relays and Governors. Arthur Rigg. A discussion of the action and performance of various regulating appliances for steam engines, giving descriptions of arrangements and combinations, with critical comments. Ill. 3500 w. Engr, Lond—Oct. 17, 1902. No. 51420 A.

**Steam Heating.**

Low-Pressure Steam Heating with Open Air Pipes. S. Naylor. Read before the Iinst. of Heat. & Ven. Engrs. (England). States the advantages of this system and gives an illustrated description. Also discussion. 4200 w. Plumb & Dec —Oct. 1, 1902. No. 51069 A.

Methods of Heating the Basement. H. H. Kelley. Illustrates and describes arrangement for heating by hot water, and also by steam. 1500 w. Engr, U S A—Oct. 15, 1902. No. 51229.

**Steaming Capacity.**

The Relation Between Heating Surface and Cylinder Power. Lawford H. Fry. Gives a measure for the steaming capacity of locomotives. 2000 w. Am Engr & R R Jour—Oct., 1902. No. 50894 C.

**Steam Mains.**

Cast vs. Wrought Iron Steam Mains. C. G. Robbins. Favoring cast mains, discussing the objections urged against them, and considering other methods of constructing steam mains. Ill. 3800 w. Power—Oct., 1902. No. 50879 C.

**Steam Turbines.**

The Steam Turbine. Its Commercial Aspect. Edward H. Sniffin. Read before the St. Ry. Assn. An inquiry into its commercial utility, giving detailed information of plants now in operation, discussing their cost, and the cost of operation as compared with steam plants. 5800 w. St Ry Rev—Oct. 11, 1902. No. 51188 C.

The Westinghouse Steam Turbine. Edwin Yawger. Read before the Ohio Elec. Lgt. Assn. An illustrated description of mechanical details of the machine and of its action. 1900 w. Am Mfr—Oct. 23, 1902. No. 51256.

Westinghouse Steam Turbines for the Rapid Transit Subway. Illustrated description of the installation for use in connection with the lighting of the subway. 1800 w. Power—Oct., 1902. No. 50880 C.

**Superheating.**

Engines for Use with Superheated Steam (Stoommachines met Hoog-Oververhittenstoom). C. F. Stork. A review of the question of superheated steam, with data and results from a number of engines in use in the Netherlands. 3500 w. Ingenieur—Oct. 11, 1902. No. 51368 D.

See Railway Engineering, Motive Power.

**Thermodynamics.**

The "Series-Vapor" and "Heat Waste" Engines, as Supplementary to Single-Vapor Engines. R. H. Thurston. A study of the problem of how to secure the largest amount of energy with the least waste. 7000 w. Jour Fr Inst—Oct., 1902. Serial. 1st part. No. 50868 D.

**Valve Gears.**

Positive and Releasing Valve Gears for Hoisting Engines (Freifall oder Zwangschleiss bei Fördermaschinen Ventilsteuerungen?) A. Ehrlich. A comparison between the reliability of trip valve gears and positively actuated valves. 1200 w. Glückauf—Sept. 27, 1902. No. 51348 B.

Some Special Problems in Valve-Gear Design by the Zeuner Diagram. Walter C. Kretz. Gives a mathematical demonstration of the problem—"Given the crank angle at cut-off, the lead, and the maximum port-opening, to find the minimum travel to suit these conditions." Also demonstrates other propositions required in the proof. 7800 w. Sch of Mines Qr—July, 1902. No. 51128 D.

The History of the Walschaert Valve-Gear. Translation of an article by M. J. Boulvin in the *Revue de Mecanique,* relating the circumstances under which Walschaert brought forth his invention. 1800 w. R R Gaz—Oct. 24, 1902. No. 51278.

## MISCELLANY.

**Alcohol.**

Lighting and Heating Apparatus (Appareils d'Eclairage et de Chauffage). G. Arachequesne. An illustrated review of the devices for utilizing alcohol in incandescent burners, and in heating appliances. 7000 w. Mem Soc Ing Civ de France—Aug., 1902. No. 51326 G.

International Alcohol Exposition of Lighting and Heating Apparatus. Translated from *La Nature.* Illustrates and describes apparatus for using alcohol as a means of heating and lighting. 1500 w. Sci Am Sup—Oct. 25, 1902. No. 51297.

**Aluminothermy.**

The Applications of Aluminothermy (L'Alumino-thermie et ses Applications). H. Bertin. A general account of the Goldschmidt process for producing high temperatures by the combustion of aluminum, and a discussion of its practical applications. 7000 w. Mem Soc Ing Civ de France—Aug., 1902. No. 51329 G.

**Artillery.**

Artillery at the Düsseldorf Exposition 1902 (Geschütze auf der Düsseldorfer Ausstellung 1902). J. Castner. A fully illustrated review of the artillery exhibits at Düsseldorf, with especial reference to the mechanical and engineering problems involved. Two articles. 5000 w. Stahl u Eisen—Oct. 1, 15, 1902. No. 51335 each D.

**Düsseldorf Exposition.**

Machinery Department of the Düsseldorf Exposition. H. L. Terwilliger. A review of the interesting exhibits, especially those using compressed air. 1600 w. Compressed Air—Oct., 1902. No. 51232.

**Refrigeration.**

Refrigeration on Shipboard. E. N. Percy. Points out some errors in refrigerating equipment on vessels, discussing points in design of apparatus, and the plan and operation of cold rooms. 4000 w. Ice & Refrig—Oct., 1902. No. 50889 C.

# MINING AND METALLURGY

## COAL AND COKE.

**Accidents.**

Fatal Accidents in Coal Mines in North America, 1901. Frederick L. Hoffman. Tabulated information with remarks. 900 w. Eng & Min Jour—Oct. 25, 1902. No. 51237.

**Briquettes.**

German Processes and Machinery for Briquette Manufacture. An account of this industry in Germany, the machines used, etc. Ill. 2500 w. U S Cons Repts, No. 1466—Oct. 11, 1902. No. 51048 D.

**By-Product Coke.**

By-Product Oven Coke Making in 1901. Edward W. Parker. From the Mineral Resources of the United States report on the Manufacture of Coke. 1800 w. Pro Age—Oct. 1, 1902. No. 50862.

**Charcoal.**

Charcoal Burning in the Lake District. Details of the business as carried on in the Furness district of Lancashire, England. 2200 w. Engng—Sept. 26, 1902. No. 50971 A.

**Coal-Fields.**

The Cumberland Plateau Coal-Field. M. S. Duffield. Explains why this valuable field in Tennessee and Kentucky has not been developed, and describes the occurrence of the coal veins and the preparations for working. Ill. 2000 w. Eng & Min Jour—Oct. 4, 1902. No. 51015.

The Identity of the Newcastle and Cumberland Coalfields. David Burns. Abstracts of a paper and its discussion before the N. of England Inst. of Min. & Mech. Engrs. Aiming to show they are two parts of the same field. 2000 w. Col Guard—Sept. 26, 1902. No. 50965 A.

**Coal Seams.**

On the Probability of Finding Workable Seams of Coal in the Carboniferous Limestone or Bernician Formation Beneath the Regular Coal Measures of Northumberland and Durham, with an Account of a Recent Boring Made in Chopwell Woods. J. B. Simpson. Read before the N. of England Inst. of Min. & Mech. Engrs. Abstracts of paper and discussion. 4000 w. Col Guard—Sept. 26, 1902. No. 50964 A.

**Coal Strike.**

See Industrial Economics.

**Coal Substitutes.**

Substitutes for Coal in Heating and Cooking. An illustrated discussion of the relative merits of other fuels, and the appliances used in burning them. 2200 w. Sci Am—Oct. 25, 1902. No. 51292.

**Coal Trade.**

See Industrial Economics.

**Dust.**

The Evils of Coal, Ganister and Slag Dust. Review of an address by Sir James Crichton Browne on the hygiene of certain occupations. 1000 w. Col Guard—Oct. 3, 1902. No. 51087 A.

**Explosions.**

Damping the Air of Coal Mines as a Safeguard Against Explosions. James Ashworth. Gives the recommendations of the Royal Commission, and discusses how far they have been carried out, and the results. Concludes that no means have yet been devised that protects with any degree of certainty. 3800 w. Ir & Coal Trds Rev—Sept. 26, 1902. No. 50973 A.

**Firedamp.**

When is Firedamp Dangerous in a Coal Mine? A discussion of this subject as presented in the inquiry into the McLaren Colliery disaster. 2000 w. Col Guard—Oct. 10, 1902. No. 51167 A.

**France.**

The Coal Mines of Northern France (Notizen über Steinkohlen Bergwerke in Nord-Frankreich). H. Stein. A general description of the Pas de Calais and Nord districts, with maps and details of installations. 6000 w. 3 plates. Glückauf—Sept. 20, 1902. No. 51347 B.

**Kansas.**

The Kansas Coal Mines of the Missouri Valley. W. R. Crane. A short description of the typical mines of this district. 4000 w. Eng & Min Jour—Oct. 18, 1902. No. 51208.

**Mine Fires.**

Fires in Coal Mines (Etude sur les Feux des Mines de Houille). J. Abadie. A study of the origin of fires in coal mines, and the most effective methods of controlling them, based upon experience in the Decazeville district, in the department of Aveyron, France. Serial. Part I. 2000 w. Génie Civil—Oct. 4, 1902. No. 51305 D.

**Peat.**

The Electrical Manufacture of Peat Fuel. Illustrates and describes a new process of carbonizing peat, invented by P. Jebsen, of Norway. 1500 w. Sci Am—Oct. 11, 1902. No. 51051.

The Utilization of the Peat Fuels of

Europe. Adolf Dal. A review of the application of mechanical devices to the cutting and milling of peat for its adaptation to power-plant service. 3500 w. Engineering Magazine—November, 1902. No. 51394 B.

**Philippines.**

Coal Beds of Cebu and Masbate: Processes of Getting the Product. Illustrates and gives information concerning these deposits in the Philippine Islands and past methods of working. 1000 w. Am Gas Lgt Jour—Oct 6, 1902. No. 50998.

**South Wales.**

The Re-Survey of the South Wales Coal Measures. An account of the re-examination of this field, giving a report of some of the work of the past year. 2800 w. Ir & Coal Trds Rev—Oct. 3, 1902. No. 51086 A.

**Storage.**

Coal Storage. Waldon Fawcett. Brief review of methods commonly employed for storing anthracite coal, with illustrations. 1200 w. Sci Am—Oct. 18, 1902. No. 51201.

**Tasmania.**

The Coal Resources of Tasmania. Hartwell Conder. An account of the varieties of coal found, the geology of the island, etc. 2200 w. Aust Min Stand—Aug. 28, 1902. No. 50162 B.

## COPPER.

**California Mine.**

The Greenback Copper Mine, Kern County, California. H. W. Turner. A description of this lode. 1100 w. Eng & Min Jour—Oct. 25, 1902. No. 51239.

**Copper.**

See Electrical Engineering, Electrochemistry.

**Ducktown.**

The Ducktown Copper Mining District. S. W. McCallie. An illustrated article describing the location of this deposit in Tennessee and Georgia, and giving an account of its discovery and operation. 1700 w. Eng & Min Jour—Oct. 4, 1902. No. 51014.

**Smelting.**

Reverbatory Copper Smelting. L. J. Charles. Gives a synopsis of the reverberatory method and discusses details. 900 w. Min Rept—Oct. 23, 1902. Serial. 1st part. No. 51287.

## GOLD AND SILVER.

**Alluvial Mining.**

Alluvial Gold-Mining Appliances. An illustrated description of machines and accessories which have proved to be of special importance in alluvial gold-mining on the Clermont field. 3500 w. Queensland Gov Min Jour—Aug. 15, 1902. Serial. 1st part. No. 50887 B.

**Concentration.**

Mexican Plannillas. Ernest E. Payne. Illustrates and describes a primitive method of concentration which has been in use in Mexico since ancient times. 1000 w. Mines & Min—Oct., 1902. No. 51046 C.

The Silver King Concentrating Mill, Park City, Utah. James H. Steele. Describes the process of concentration of the lower grade ores as carried out at this mill, which has a capacity of about 100 tons in ten hours, and at present is running 19 hours out of every 24. Ill. 1600 w. Min & Sci Pr—Oct. 11, 1902. No. 51181.

**Dutch East Indies.**

The Mining and Occurrence of Gold in the Dutch East Indies. S. J. Truscott. Abstract of a paper read before the Inst. of Min & Met., London. The present article gives an account of what has been done toward developing the mines of Sumatra and Borneo. Map. 2900 w. Eng & Min Jour—Oct. 4, 1902. Serial. 1st part. No. 51016.

**Extraction.**

Extraction from Low Grade Ores. Begins a description of the Schilz process for the extraction of gold. 1500 w. Aust Min Stand—Aug. 21, 1902. Serial. 1st part. No. 50951 B.

**Goldfield.**

The Clermont Goldfield. A report by B. Dunstan, assistant government geologist. Describes the geological considerations, the alluvial deposits, etc., of this district in Queensland. 11500 w. Queensland Gov Min Jour—Aug. 15, 1902. Serial. 1st part. No. 50888 B.

**Nome.**

Gold Mining in the Nome District. Lewis Garrison. An account of the companies formed, and the need of water, showing that the district has passed largely into the hands of companies with large capital. 1200 w. Eng & Min Jour—Oct. 4, 1902. No. 51017.

**Ore Treatment.**

Improvements in the Treatment of Gold Ores (Neuerungen in der Behandlung von Golderzen). Hermann Pape. With especial reference to the preparation of gold ores for treatment by the cyanide process. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 27, 1902. No. 51316 D.

**Slimes.**

The Smelting and Refining of Zinc Gold Slimes. E. H. Johnson and W. A. Caldecott. A discussion of methods and results. 3400 w. Jour of Chem & Met

Soc of S. Africa—July, 1902. No. 50-846 E.

**Smelting.**

The New Smelter Plant at Crofton. W. M. Brewer. Illustrated description of this plant, on the east coast of Vancouver Is. 1500 w. B C Min Rec—Oct., 1902. No. 51120 B.

**Stamp Mills.**

Stamp Mill Construction. J. J. Deming. Condensed from a paper read before the Mining Congress. On the need of adapting mills to the requirements of the ore to be treated, considering important factors. 4000 w. Min & Sci Pr—Oct. 4, 1902. No. 51039.

**Treatment.**

Mexican Methods of Silver Ore Treatment. J. Nelson Nevins. An illustrated description of the patio process, developed in the middle of the sixteenth century. 800 w. Eng & Min Jour—Oct. 18, 1902. No. 51207.

## IRON AND STEEL.

**Billet Mill.**

New Billet Mill at Youngstown. Illustrations and details of the Republic Iron & Steel Co.'s new mill. 1000 w. Ir Trd Rev—Oct. 9, 1902. No. 51038.

**Düsseldorf.**

The Iron Manufacturing Industry (Das Eisenhüttenwesen). Fr. Frölich. An illustrated review of the exhibits at the Düsseldorf exposition relating to the iron and steel industries. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 20, 1902. No. 51312 D.

The Metallurgy of Iron and Steel (La Metallurgie du Fer et de l'Acier). Alexandre Gouve. A very complete review of the exhibits at the Düsseldorf exposition relating to the manufacture of iron and steel and the allied industries. 20,000 w. 6 plates. Rev Univ des Mines —Aug., 1902. No. 51331 G.

**Electric Driving.**

See Electrical Engineering, Power Applications.

**Germany.**

Progress of German Steel and Rolling Mills since 1880 (Die Fortschritte in den Deutschen Stahl und Walzwerken seit 1880). R. M. Daelen. A brief review of German progress in steel making, showing especially the advance in the production of steel by the basic process. 2000 w. Stahl u Eisen—Sept. 15, 1902. No. 51333 D.

The Development of Pig Iron Manufacture in Germany since 1880 (Die Fortschritte in der Roheisenerzeugung Deutschlands seit 1880). W. Brügmann. Giving diagrams showing the enormous progress made in the past 20 years. Two articles. 7500 w. Stahl u Eisen—Sept. 15, Oct. 1, 1902. No. 51332 each D.

The Iron Industry in Germany from a Technical Point of View. W. Brugmann. Read at the Düsseldorf meeting of the Ir. & Steel Inst. Remarks on the progress in the manufacture of coke, and discussion of details in German blast furnaces. 2800 w. Ir Trd Rev—Oct. 23, 1902. No. 51-262.

**Hot Blast.**

Results Obtained in Equalizing the Temperature of Hot Blast. Lawrence F. Gjers and Joseph H. Harrison. Read at Düsseldorf meeting of the Iron & Steel Inst. Illustrated description of an equalizer with report of its work. 2000 w. Ir & Steel Trds Jour—Sept. 27, 1902. No. 50915 A.

**Ingots.**

Compressing Steel Ingots by Wire Drawing in the Ingot Mold. An illustrated description of apparatus as given in a paper by A. Harmet, read at Düsseldorf meeting of the Iron & Steel Inst. 2500 w. Eng News—Oct. 2, 1902. No. 50925.

**Iron Ores.**

The Mesaba Range. Reviews a report prepared by Charles K. Leith for the U. S. Geol. Surv., considering the origin and development of the ore deposits of this iron-bearing district. 4000 w. Ir Age—Oct. 23, 1902. No. 51213.

The Valuation of Iron Ores and Other Raw Materials (Die Bewerthung von Eisenerzen und anderen Schmelzstoffen). Bernhard Osann. A detailed examination of the elements involved in the valuation of the ore coke, flux and other materials used in the making of iron, based on their relative uses in the furnace. Two articles. 6000 w. Stahl u Eisen—Oct. 1, 15, 1902. No. 51334 each D.

**Iron Works.**

The Cette Iron Works (Les Haut Fourneaux et Forges de Cette). Ch. Dantin. An illustrated description of the new blast furnaces and forges of Messrs. Schneider & Co., at Cette; department of Hérault, France. 2500 w. 1 plate. Génie Civil—Oct. 11, 1902. No. 51306 D.

**Sulphur.**

Sulphide of Iron (Sulfure de Fer). MM. Le Chatelier & Ziegler. A study of the state in which sulphide of iron exists in cast iron, and the nature of its influence upon the metal. 7000 w. Bull Soc d'Encour—Sept. 30, 1902. No. 51-322 G.

**Tin Plate.**

The Manufacture of Tin Plate. An illustrated description of this industry as carried on at the Laughlin Works of the

American Tin Plate Co., at Martin's Ferry, Ohio. 1600 w. Sci Am—Oct. 4, 1902. Serial. 1st part. No. 50937.

**Titanium.**

The Metallurgy of Titanium. Auguste J. Rossi. A discussion of this class of iron ores, the objections against them, the experimental researches made, their value under proper treatment, results obtained, tests, etc. 7000 w. Jour Fr Inst—Oct., 1902. No. 50867 D.

## MINING.

**By-Products.**

The Residual Products of the Dynamite Factory and Their Value to the Gold Industry. William Cullen. Aims to show that many of these by-products could be utilized in the mining industry. 3300 w. Jour Chem & Met Soc of S Africa—Aug., 1902. No. 50950 E.

**Electric Power.**

See Electrical Engineering, Power Applications.

**Explosives.**

Testing Mine Explosives. A. W. Warwick. Showing the difficulties and uncertainties in determining practical values of different explosives. 2000 w. Mines & Min—Oct., 1902. No. 51042 C.

**Japan.**

The Mining Industry of Japan. E. W. Nardin. The present article considers copper mining, this country standing third as a producer of this metal. Ill. 1700 w. Aust Min Stand—Sept. 4, 1902. Serial. 1st part. No. 51063 B.

**Mine Locomotives.**

Benzine Locomotives for Gaseous Mines (Benzinlocomotive für Schlagwettergruben). L. Volf. Describing a convenient form of mine locomotive operated by an Otto benzine motor for use in localities in which electric sparking might be dangerous. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 4, 1902. No. 51346 D.

**Mining Plant.**

Notes on Machinery Constituting a Mining Plant. Alfred C. Garde. Notes written with a particular view to conditions in British Columbia, but useful to mine investors and engineers in charge of any mining properties. 2000 w. Can Min Rev—Sept. 30, 1902. No. 51005 B.

**Mining Railway.**

The Underground Railway of the Stassfurt Salt Mines (Die Untergrundbahn des Königlichen Salz werkes zu Stassfurt). J. Westphal. Illustrating and describing the electric railway system recently installed in the Stassfurt salt mines. 4000 w. 3 plates. Glückauf—Oct. 4, 1902. No. 51349 B.

**Power Distribution.**

Distribution of Power in English Mines. Sydney F. Walker. Considers the use of ropes and chains and the causes of loss and waste of power. 2000 w. Mines & Min—Oct., 1902. No. 51047 C.

**Shafts.**

Shaft Sinking. C. K. Colvin. Points from the writer's experience on the subject of sinking and timbering perpendicular cage shafts for the working of metalliferous mines. 1800 w. Min & Sci Pr—Oct. 4, 1902. No. 51040.

**Signalling.**

Mine Signalling by Compressed Air. Bernard MacDonald and William Thompson. Discusses methods of signalling from the mine workings to the engineer running the hoisting engine. Describes the system in general use and illustrates and describes the compressed air signal system, stating its advantages. 3000 w. Can Min Rev—Sept. 30, 1902. No. 51-003 B.

**Surveying.**

Shaft Surveying. T. Lane Carter. Deals with the practice in the Johannesburg gold-fields for surveying vertical shafts. 2000 w. Eng & Min Jour—Oct. 11, 1902. No. 51109.

**Timbering.**

Mine Timbering by the Square Set System at Rossland, B. C. Bernard MacDonald. Describes the vein characteristics at Rossland, and the methods of construction used. Ill. 5400 w. Can Min Rev—Sept. 30, 1902. No. 51002 B.

**Vancouver Is.**

Mineral Resources of Vancouver Island. W. M. Brewer. Read before the Can. Min. Inst. Gives a brief history of the coal mining and metal mining, geological formation, production, etc. 4500 w. Can Min Rev—Sept. 30, 1902. No. 51004 B.

**Winding.**

The Mexican Malacate. J. Nelson Nevins. Illustrated description of an apparatus used in Mexico for purposes of sinking, prospecting or ventilating shafts, or for development work. 900 w. Eng & Min Jour—Sept. 27, 1902. No. 50829.

## MISCELLANY.

**Alloys.**

See Electrical Engineering, Electro-Physics.

**Aluminum.**

Aluminum as a Reducing and Heat Producing Agent. H. Hofman. Discusses the action of aluminum as a reducing agent, giving a review of the early applications, and also the more recent, especially of the Goldschmidt process. 4000 w. Am Mfr—Sept. 25, 1902. No. 50827.

**Borax.**

Reconnaissance of the Borax Deposits of Death Valley and Mohave Desert. Marius R. Campbell. Describes these deposits, and their development. Ill. 2300 w. Eng & Min Jour—Oct. 18, 1902. No. 51209.

**Calcium.**

See Electrical Engineering, Electrochemistry.

**Galena-Joplin.**

Recent Changes in Mining and Milling in the Galena-Joplin Lead and Zinc District. W. R. Crane. Considers the methods of leasing and mining, milling, etc. Ill. 3200 w. Eng & Min Jour—Sept. 27, 1902. No. 50828.

**Gypsum.**

Recent Developments in the Gypsum Industry in New York State. From report of the N. Y. State Geologist, Arthur L. Parsons. Describes the quarries at Fayetteville and their working. 2500 w. Stone—July, 1902. No. 51140 C.

**Lead.**

On the Determination of Lead in Ores. Irving C. Bull. A comparison of the best existing methods in order to select a method which may be recommended both because of its accuracy and rapidity. 4300 w. Sch of Mines Qr—July, 1902. No. 51129 D.

See Electrical Engineering, Electrochemistry.

**Petroleum.**

Notes and Methods on the Determination of Water, Sand, etc., in Crude Petroleum of Low Gravity. P. W. Tompkins. Read before the Pacific Coast Gas Assn. Describes methods tried on California oils. 4000 w. Am Gas Lgt Jour—Sept. 29, 1902. No. 50837.

Prospecting for Oil in Wyoming. Prof. Arthur Lakes. A description of the prospects in the country around Medicine, Butte and Red Mountain, Uinta Co. 2700 w. Mines & Min—Oct., 1902. No. 51043 C.

The Chanute Oil Fields in Kansas. Erasmus Haworth. Describes the location, prospecting, and development of these fields and their interesting features. 1500 w. Eng & Min Jour—Oct. 11, 1902. No. 51108.

The Present Condition of the Oil Industry of California. W. G. Young. Considers influences that have affected the industry, and difficulties that have retarded its development. 1200 w. Eng & Min Jour—Oct. 25, 1902. No. 51238.

**Zinc.**

Zinc in Crittenden County, Ky. George D. Wheeler. An illustrated description of the Blue & Nunn Mine, the deposits and method of mining. 1000 w. Eng & Min Jour—Sept. 27, 1902. No. 50830.

See Electrical Engineering, Electrochemistry.

# RAILWAY ENGINEERING

## CONDUCTING TRANSPORTATION.

**Cars.**

Private Cars. J. W. Midgley. An inquiry into their growth, developments and operations. 5800 w. 2 parts. Ry Age—Oct. 10 and 17, 1902. No. 51118.

**Natal.**

The Growing Railway System of Natal. J. Hartley Knight. An interview with the general manager, Sir David Hunter, showing the development of the system; with many illustrations. 4000 w. Engineering Magazine—Nov. 1, 1902. No. 51393 B.

**Telephone Service.**

Railroad Telephone Service. Waldon Fawcett. Gives some of the uses made of this means of communication in railway service. 1500 w. Loc Engng—Oct., 1902. No. 50863 C.

## FINANCIAL.

**Assessment.**

The True Principles for Assessment of Railway Property. Principles laid down in a decision by the Supreme Court of Nebraska. 1500 w. Ry Age—Oct. 3, 1902. No. 51001.

**Panama.**

The Panama Railroad. Reviews the history of this road, giving report of the earnings of the last year, and remarks on its relation to the isthmian canal project. 1500 w. Engr, Lond—Oct. 10, 1902. No. 51174 A.

**Purchase.**

The Atlantic Coast Line Purchase of the Control of the Louisville & Nashville. Information concerning the terms of the sale, and plans for the future development. 1800 w. R R Gaz—Oct. 3, 1902. No. 50933.

## MOTIVE POWER AND EQUIPMENT.

**Blast Nozzles.**

Exhaust Discharge Nozzles for Locomotives (L'Echappement dans les Machines Locomotives). H. Noalhat. An exhaustive discussion of the use of the exhaust steam to assist the draft of locomotive boilers, with illustrations of nozzles used in various countries. 4500 w. Revue Technique—Oct. 10, 1902. No. 51310 D.

**Brakes.**

High-Speed Brakes. The report of Mr. Nellis, with general discussion. 1200 w. Cent Ry Club—Sept. 12, 1902. No. 51-177 C.

Proper Air-Brake Instructions, and Handling of Air-Brakes on Freight Trains. Extracts from a committee report to the annual meeting of the Traveling Engineers' Assn. 3000 w. Ry & Engng Rev—Oct. 4, 1902. No. 50997.

**Cars.**

A Combined Caboose and Repair Car. Illustrates and describes a car designed especially to accompany trains of all steel cars, thus furnishing facilities for any repairs made necessary by a collision. 900 w. Ry & Engng Rev—Oct. 11, 1902. No. 51149.

Coal Car for the Philadelphia & Reading. Illustrates and describes the latest design for a hopper bottom self-cleaning coal car of 80,000 lbs. capacity. 500 w. Ry Age—Oct. 24, 1902. No. 51264.

High Capacity Wagons. An account of tests on the North-eastern Railway to determine the most economical type for mineral traffic. Illustrates and describes the 40-ton coal wagon on trial. 2300 w. Ir & Coal Trds Rev—Oct. 3, 1902. Serial. 1st part. No. 51084 A.

New Designs of 100,000 lbs. Capacity Gondolas for the Pennsylvania. Illustrated descriptions of two new designs, one having a steel underframe with wooden body, and the other being all steel. 800 w. R R Gaz—Oct. 10, 1902. No. 51101.

**Coal Trucks.**

The Ownership and Capacity of Railway Coal Trucks. Discusses the tendency in England toward increasing the size of the coal cars, and the problems arising in connection with the large number of firms owning private cars. 1800 w. Jour Gas Lgt—Oct. 14, 1902. No. 51246 A.

**Flues.**

One Cause of Leaky Flues. S. W. Miller. Mentions the primary cause as bad water, and discusses the setting of flues. General discussion follows. 2400 w. W Ry Club—Sept. 16, 1902. No. 51-179 C.

**Locomotive Design.**

Possibilities in American Locomotive Design. W. F. M. Goss. An address delivered at the Deer Park Convention of B. & O. officers. Reviews the past development of American roads, and discusses the characteristics of the future locomotive. 6000 w. R R Gaz—Oct. 17, 1902. No. 51226.

**Locomotives.**

Compound Freight Locomotive for the Norwegian State Railway (Die Verbund Güterzuglokomotive der Norwegischen Staatsbahnen). Illustrated description of ten-wheel, two-cylinder freight engine, built by the Winterthur Works. 1000 w. 1 plate. Schweizerische Bauzeitung—Oct. 4, 1902. No. 51337 B.

Fast Express Locomotive for the Big Four R. R. Illustrated description of a very heavy locomotive, with critical comments. 1000 w. Eng News—Oct. 23, 1902. No. 51283.

Passenger Locomotive for Big Four. Illustrated detailed description of a recent design of the Atlantic type. 800 w. Ry Age—Oct. 24, 1902. No. 51263.

Six-Coupled Switching Locomotive. Illustrated description of locomotives for the L. S. & M. S. Ry. designed for heavy yard service. 500 w. Am Engr & R R Jour—Oct., 1902. No. 50895 C.

Tank Engine for the Llanelly and Mynydd Mawr Railway. Illustration and particulars of a powerful side tank locomotive recently built. 250 w. Engr, Lond—Oct. 3, 1902. No. 51089 A.

Ten-Wheel Compound Passenger Locomotive, Canadian Pacific Ry. Engraving and outline diagram of recently built engine designed to burn bituminous coal. 1200 w. Ry & Engng Rev—Sept. 27, 1902. No. 50832.

Ten-Wheel Freight Locomotives for the C. H. & D. Ry. Brief illustrated description. 500 w. Ry & Engng Rev—Oct. 11, 1902. No. 51148.

**Locomotive Tender.**

Tender for Oil-Burning Locomotives. Illustrated description. 600 w. R R Gaz—Oct. 3, 1902. No. 50932.

**Lubrication.**

The Consumption of Lubricants on Prussian State Railways (Der Schmierölverbrach für die Lokomotiven der Preussischen Staats-Eisenbahnen). A. Baum. With numerous tables, showing the quantity of lubricant required per engine-kilometer and per 1000 kilometer for various kinds of locomotives. Two articles, 4000 w. Glasers Annalen—Oct. 1, 15, 1902. No. 51339 each D.

**Oil Fuel.**

Oil Fuel for Locomotives. Abstract of a paper by James McDonough presented before the Traveling Engrs.' Convention. Concerning the changes necessary to convert a coal to an oil burning locomotive. Also gives report of tests made by the Santa Fe Pacific R. R. to determine the relative economy of oil and coal in freight service. 1000 w. R R Gaz—Oct. 10, 1902. No. 51102.

**Scrap.**

Locomotive and Car Scrap. T. A. Lawes. Illustrated description of scrap bins and a report of the good results from their use. Discussion follows. 7000 w. W Ry Club—Sept. 16, 1902. No. 51178 C.

**Shops.**

A New Locomotive Erecting Shop (Nouvel Atelier de Montage des Locomotives). M. Desgeans. An illustrated description of the important new works of the Eastern Railway of France at Epernay. Two articles, 6 plates. Rev Gen des Chem de Fer—Sept., Oct., 1902. No. 51378 each H.

A Typical Shop to Serve a Road or Division Equipped with 300 Locomotives. L. R. Pomeroy. Extracts from a paper presented to the Mas. Mechs.' Assn. Con. Suggestions for shop construction and arrangement. Also discussion. 3000 w. R R Gaz—Oct. 24, 1902. No. 51280.

Improvements in the Schenectady Works of the American Locomotive Co. Illustrates and describes new buildings, including a boiler shop, foundry, blacksmith shop, tank shop, hammer shop and drop forge shop, besides minor structures. 1600 w. R R Gaz—Oct. 3, 1902. No. 50931.

New Locomotive and Car Shops. The first of a series of illustrated articles describing the new shops at Collinwood, Ohio. 4000 w. Am Engr & R R Jour—Oct., 1902. Serial. 1st part. No. 50891 C.

San Bernardino Shops of the Santa Fe System. Illustrated description of the complete transformation of the old plant, with new construction and additions which will give a new arrangement throughout. 1200 w. Ry Age—Sept. 26, 1902. No. 50831.

The Memphis Shops of the Illinois Central. Illustrates and describes improvements that will greatly increase the present terminal facilities. 1100 w. R R Gaz—Oct. 17, 1902. No. 51227.

**Stoker.**

The Kincaid Locomotive Stoker. Illustrates and describes an invention which gives promise of great utility, adding to the efficiency, economy and abatement of smoke in locomotives. 1000 w. Sci Am Sup—Oct. 25, 1902. No. 51296.

**Superheated Steam.**

The Use of Superheated Steam in Locomotives. Condensed translation from *Glaser's Annalen für Gewerbe und Bauwesen*, discussing the use of the Schmidt superheater on German locomotives. Ill. 3000 w. R R Gaz—Oct. 10, 1902. No. 51103.

**Train Lighting.**

Electric Train-Lighting in Germany. Editorial review of an interesting paper by Herr Geheimer Oberbaurath Wichert, printed in the *Glaser's Annalen*, giving particulars of recent experiments in the matter of train-lighting by electricity, carried out in the Prussian State Railways. 1500 w. Engng—Oct 10, 1902. No. 51170 A.

**Water Service.**

Improvement of Water Service on Railways. Describes the work of improving the water for locomotive service as carried out by a company in Chicago, which has in course of construction, 16 plants with a capacity of 3,756,000 gals. per day. Ill. 4300 w. Ry & Engng Rev—Oct. 18, 1902. No. 51210.

## NEW PROJECTS.

**China.**

Chinese Railway Development. An account of what has been accomplished in railway building. 1200 w. Transport—Oct. 3, 1902. No. 51057 A.

**Engadine.**

The Engadine Railway (Le Chemin de Fer de l'Engadine). H. Martin. A fully illustrated account of the construction of a narrow gauge steam railway, from Coire to St. Moritz, Switzerland. The Albula tunnel and several important viaducts are discussed. 3000 w. 1 plate. Génie Civil—Oct. 4, 1902. No. 51304 D.

**Inclined Railway.**

The Weehawken Inclined Railway. Charles L. Duenkel. An illustrated description of a road which runs from the lowlands to the Mountain Road at the top of the Palisades, opposite New York. 4500 w. Eng News—Oct. 16, 1902. No. 51216.

## PERMANENT WAY AND FIXTURES.

**Construction.**

Railway Building Through a Forest. Illustrated description of work on the Hoquiam branch of the Northern Pacific R. R. in the state of Washington. 800 w. Ry Age—Oct. 3, 1902. No. 51000.

**Cut-Off.**

Ogden-Lucin Cut-Off—Central Pacific Ry. An account of progress of this work, which crosses the Great Salt-Lake, and the interesting methods of construction. Ill. 2000 w. R R Gaz—Oct. 24, 1902. No. 51279.

**Embankments.**

The Construction and Maintenance of Railway Embankments. Editorial discussion of practice in America and in England, and the causes of settlement, shipping, etc. 2000 w. Eng News—Oct. 9, 1902. No. 51097.

**Improvements.**

Reconstruction of the Richmond-Washington Line. Brief account of changes, including the double-tracking of the entire line. 600 w. Ry Age—Oct. 3, 1902. No. 50999.

**Office Buildings.**

The Grand Trunk's New Office Building. Illustrated detailed description of this recently completed fine building in Montreal. 1300 w. Ry Age—Oct. 17, 1902. No. 51193.

**Rails.**

Steel Rails: Specifications. Robert Job. Gives the Philadelphia & Reading Railway Company's Specifications, and information gained by careful investigations and experience. 2700 w. Am Engr & R R Jour—Oct., 1902. No. 50893 C.

**Renewal.**

The Quick Renewal of Permanent Way. Considers methods and points needing care, and means of avoiding accidents while the work is in progress. 5000 w. Engr, Lond—Oct. 17, 1902. No. 51418 A.

**Round-Houses.**

Increased Light for Round-Houses. T. A. Lawes. Brief illustrated description of a method of wall construction permitting larger window area. 500 w. Am Engr & R R Jour—Oct., 1902. No. 50892 C.

**Signals.**

Electro-Pneumatic Interlocking at Albany. Diagrams showing the tracks and signals, with explanatory notes. 600 w. R R Gaz—Oct. 24, 1902. No. 51277.

The Taylor Electric Interlocking System. An illustrated detailed description of this system and its working. 5400 w. Eng News—Oct. 2, 1902. No. 50929.

The Union Electric Semophore Signal. Illustrates and describes the mechanism and electric connections of an automatic system of railway signalling. 1100 w. Sci Am Sup—Oct. 25, 1902. No. 51294.

### TRAFFIC.

**Freight.**

Freight Rates in Illinois. Statement in full of the C. B. & Q. Railway to the Quincy Freight Bureau. 3200 w. Ry Age —Oct. 17, 1902. No. 51194.

**Ireland.**

The Belfast and Northern Counties Railway. Reviews the history of this line, soon to be amalgamated with the Midland Railway Company. Ill. 3000 w. Transport—Oct. 10, 1902. No. 51153 A.

**New Zealand.**

New Zealand Government Railways. Information from the railways statement for the year ending March 31, 1902, with map. 1200 w. Transport—Sept. 19, 1902 Serial. 1st part. No. 50960 A.

**"Owner's Risk."**

The Railway Companies and "Owner's Risk." Discusses a proposed alteration which the British railway companies are endeavoring to carry through. 1700 w. Engr, Lond—Sept. 26, 1902. No. 50968A.

**Tractive Force.**

The Tractive Force of Locomotives. Edward L. Coster. Most of the article is a compilation from the paper entitled "Practical Tonnage Rating," presented at the 1901 convention of the Master Mechanics' Assn., by George R. Henderson, and from information supplied in private correspondence. 1700 w. Am Engr & R R Jour—Oct., 1902. No. 50896 C.

# STREET AND ELECTRIC RAILWAYS

### MISCELLANY.

**Acceleration.**

The Liverpool Overhead Railway. Results of high acceleration extracted from a recently issued pamphlet. 2000 w. Transport—Oct. 17, 1902. No. 51407 A.

The Relation of Energy and Motor Capacity to Schedule Speed in the Moving of Trains by Electricity. Discussion of Dr. Cary T. Hutchinson's paper. Plates. 12300 w. Trans Am Inst of Elec Engrs—June & July, 1902. No. 51138 D.

**Accidents.**

The Accident on the Glasgow Tramways. Full report made to the Board of Trade by the inspector who inquired into the accident. 2000 w. Elect'n, Lond—Oct. 17, 1902. No. 51415 A.

**Address.**

President Vreeland's Address before the American Street Railway Association. Remarks on the legal and social state of electric railroads, and the problems to be solved in connection. 3000 w. St Ry Rev —Oct. 9, 1902. No. 51225 C.

**Benefit Associations.**

Street Railway Mutual Benefit Associations. Oren Root, Jr., Read at the Detroit meeting of the St. Ry Con. Gives details of the workings of the Metropolitan Street Railway Association of New York. 2700 w. St Ry Jour—Oct. 11, 1902. No. 51145 D.

**Berlin.**

The Latest Developments of the Berlin Elevated and Underground Railway.

Frank C. Perkins. An illustrated description of the line and its equipment. 2800 w. Elec Rev, N Y—Oct. 11, 1902. No. 51106.

**Car Control.**

Tram Car Driving. H. B. Phillimore. Describes the equipment for controlling the car, and its manipulation, giving suggestions for motor-drivers. 1700 w. Elec Rev, Lond—Oct. 10, 1902. No. 51161 A.

**Car Equipment.**

Interurban Electric Railway Car Equipment. W. B. Potter. Discusses some of the conditions met with in determining the equipment for various types of service, describing only such apparatus as has passed the experimental stage. 3500 w. St Ry Jour—Oct. 4, 1902. No. 50988 D.

**Cars.**

Cars for High Speed Interurban Service. An illustrated study of some of the recent designs used by electric interurban railways. 3700 w. St Ry Jour—Oct. 4, 1902. No. 50992 D.

**Car Tests.**

Tests of Interurban Cars of Union Traction Company of Indiana. Clarence Renshaw. A report of tests made between Muncie and Indianapolis, with curves showing results. Ill. 3800 w. St Ry Jour—Oct. 4, 1902. No. 50990 D.

**Construction.**

The Artistic Treatment of Electric Railway Line Construction. H. P. Quick. Illustrates many pole designs for the support of the wires. Compares American and foreign practice. 1200 w. St Ry Rev—Sept. 20, 1902. No. 50908 C.

**Damage Claims.**

The Adjustment of Damage Claims. Mason B. Starring. Discusses some of the difficulties, offering suggestions concerning adjustment. 5400 w. St Ry Rev—Oct. 11, 1902. No. 51190 C.

**Detroit.**

Detroit as an Interurban Electric Railway Center. Map and information, showing the great number of interurban lines centering in this city. 1500 w. St Ry Jour—Oct. 4, 1902. No. 50975 D.

Flint Division of Detroit United Railway Company. S. T. Dodd. Illustrates and describes a plant of S. K. C. rotaries which works very successfully on this long distance line. 2800 w. Elec Wld & Engr—Oct. 4, 1902. No. 51018.

Motive Power and Rolling Stock of the Detroit United Railway. Thomas Farmer. Illustrated detailed description of the power houses and battery stations, and various types of cars, etc. 3700 w. St Ry Jour—Oct. 4, 1902. No. 50977 D.

Motive Power and Rolling Stock on the Rapid Railway. Illustrates and describes these features of the Detroit & Port Huron Shore Line Railway. 1500 w. St Ry Jour—Oct. 4, 1902. No. 50982 D.

Overhead Construction and Electric Power Distribution of the Detroit United Railway System. An illustrated article describing types of construction, materials, power distribution, and the work in general. 2200 w. St Ry Jour—Oct. 4, 1902. No. 50980 D.

Power Stations of the Detroit United Railway. Thomas Farmer. Illustrated detailed description. 2800 w. St Ry Rev—Sept. 20, 1902. No. 50904 C.

Review of the Detroit United Railway System from an Operating Standpoint. A. H. Stanley. Map and illustrations. 3500 w. St Ry Rev—Sept. 20, 1902. No. 50903 C.

The General Passenger Department of the Detroit United Railway System. Explains conditions and discusses the work of this department. 2000 w. St Ry Jour—Oct. 4, 1902. No. 50981 D.

The Rapid Railway System. F. W. Brooks, W. O. Wood and A. C. Marshall. An illustrated article giving a full account of the Detroit & Port Huron Shore Line Railway, its equipment and operation. 3800 w. St Ry Rev—Sept. 20, 1902. No. 50905 C.

The Street Railways of Detroit. An illustrated article giving the history of their development, with a review of the agitation for low fares, and a table showing the relations of the different companies forming the Detroit United Railway. 4500 w. St Ry Rev—Sept. 20, 1902. No. 50902 C.

**Discipline.**

Discipline for Street Railway Employes. W. F. Harrington. Gives rules for the government of conductors and motormen on the Camden & Suburban railway, and the results of the "demotion" system, describing its essential features. 2200 w. St Ry Rev—Sept. 20, 1902. No. 50910 C.

**Electric Locomotive.**

A 10,000-Volt Locomotive. Illustrated detailed description of a locomotive built for the high-speed, high-pressure electric railway experiments near Berlin. 2000 w. Elect'n, Lond—Oct. 17, 1902. No. 51414 A.

**Electric Traction.**

Electric Traction in Its Relation to Existing Railways. J. W. Jacomb-Hood. Extract from a paper read before the London and South-Western Ry. Debating Soc. Discusses mainly its application to suburban service, and the cost. 2000 w. Elect'n, Lond—Oct. 17, 1902. No. 51416A.

**Elevated Railway.**

Application of Electric Traction to the New York Elevated Railways (Application de la Traction Electrique au Chemin de Fer Metropolitain de New York). H. Martin. A description of the conversion of the New York elevated railway system from steam to electric traction. Serial. Part I. 3000 w. 1 plate. Génie Civil—Sept. 13, 1902. No. 51300 D.

**England.**

Suburban Traffic Conditions of London, England. Philip Dawson. An explanation of the conditions, and the system of railway lines existing and proposed which are expected to meet all requirements. Maps. 6000 w. St Ry Jour—Oct. 4, 1902. No. 50991 D.

**Europe.**

Electric Railway Schemes in Europe. A statement of present conditions, and what is being done at various centers. 1700 w. Engr, Lond—Oct. 17, 1902. No. 51419 A.

**Exposition.**

Electric Railways and the St. Louis Exposition. W. E. Goldsborough. An illustrated article giving information concerning the transportation and electrical buildings and electric railway exhibits. 2800 w. St Ry Rev—Oct. 20, 1902. No. 51243 C.

**Fares.**

Collection and Registration of Fares on City and Suburban Lines. William C. Sampson. Read at meeting of St. Ry. Accountants' Assn. Briefly describes the various systems tried by the Union Traction Co. of Indiana. 2700 w. St Ry Rev—Oct. 9, 1902. No. 51186 C.

**Freight.**

Electric Express and Package Delivery. George Parker. Read at the Detroit meeting of the St. Ry. Con. Describes the system, methods employed, and general management of the express business on the roads about Detroit. 3500 w. St Ry Jour—Oct. 11, 1902. No. 51147 D.

Freight Business on Detroit Interurban Roads. An illustrated account of methods of conducting an extensive business in competition with steam roads. 1500 w. St Ry Jour—Oct. 4, 1902. No. 50979 D.

Handling Freight and Express on Interurban Electric Railways. Albion E. Lang. Describes this work as carried out on the interurban roads of Northwestern Ohio. Ill. 3800 w. St Ry Jour—Oct. 4, 1902. No. 50986 D.

**Interurban.**

An Electric Traction System Employing Single-Phase Alternating Current. Gives the paper describing this new system, presented by B. G. Lamme, at the recent meeting of the Am. Inst. of Elec. Engrs., with editorial comment. 5300 w. Eng News—Oct. 2, 1902. No. 50927.

From the Lake Region to the Atlantic Sea Board by Trolley. R. H. Derrah. An illustrated account of a trip from Port Huron, Mich., eastward to the sea. Brief descriptions of many lines and the towns and cities through which they pass. Maps. 10300 w. St Ry Rev—Oct. 20, 1902. Serial. 1st part. No. 51244 C.

Interurban Road Through Ohio Oil Field. Illustrated description of the Toledo, Fostoria & Findlay Railway, and its operation. 2000 w. St Ry Jour—Sept. 27, 1902. No. 50835 D.

Power Distribution and Operating Points on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway. An illustrated article considering points of interest in the working of this long interurban electric road. 2000 w. St Ry Jour—Oct. 4, 1902. No. 50984 D.

Single Phase Electric Railway System. B. G. Lamme. Read at meeting of the Am. Inst. of Elec. Engrs. A description of the new high-speed electric line extending from the suburbs of Washington to Baltimore, with a branch to Annapolis. 8000 w. Elec Wld & Engr—Oct. 4, 1902. No. 51021.

The Accounting Department of Interurban Railways. W. B. Brockway. Discusses the many problems that arise in planning a system of accounting. 6800 w. St Ry Jour—Oct. 4, 1902. No. 50987 D.

The Aurora, Elgin & Chicago Railway. This noted interurban road is especially notable for its speed. This article discusses the elements which make this speed possible. Ill. 6600 w. St Ry Jour—Oct. 4, 1902. No. 50995 D.

The Boston & Worcester Street Railway. An illustrated description of one of the latest interurban roads of New England, representing the most advanced practice. 5700 w. St Ry Jour—Oct. 4, 1902. No. 50993 D.

The Oley Valley Railway. Illustrates and describes one of the most interesting interurban lines in Pennsylvania. 4000 w. St Ry Jour—Oct. 4, 1902. No. 50994 D.

The Operation of Electric Interurban Railways. W. O. Wood. Discusses the problems and needs of these roads. 2500 w. St Ry Jour—Oct. 4, 1902. No. 50983 D.

The System of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway. F. E. Merrill. Illustrates and describes this road which was the first to construct 40 miles of track. 3500 w. St Ry Rev—Sept. 20, 1902. No. 50906 C.

Track and Overhead System for an Interurban Electric Railway. Concerning the economy and advisability of the best construction, with estimate of cost. 3500 w. St Ry Rev—Oct. 20, 1902. No. 51245 C.

**London Tramways.**

The Electrification of the South London Tramways. Begins an account of the work of reconstruction, stating why the conduit system was adopted, and the proposed extensions. Ill. 1800 w. Engng—Oct. 3, 1902. Serial. 1st part. No. 51091 A.

**Repair Shops.**

The Most Economical Management of the Repair Shop. Charles S. Banghart. Read at meeting of the Penn. St. Ry. Assn. Gives a list of machines found most generally useful, with suggestions as to their arrangement, and the work of the shop in general. 1700 w. St Ry Rev—Sept. 20, 1902. No. 50909 C.

**Rolling Stock.**

New Fireproof Rolling Stock for the Central London Underground Railway. Gives an illustrated abstract of the plans and specifications of the motor cars and other parts of the equipment. 3000 w. St Ry Jour—Oct. 11, 1902. No. 51144 D.

**Rules.**

Report of Committee on Standard Code of Rules for the Government of Conductors and Motormen. Submitted at the Caldwell meeting of the St. Ry. Assn. 4000 w. St Ry Jour—Sept. 27, 1902. No. 50836 D.

**Signals.**

Signals for Urban and Interurban Railways. G. W. Palmer, Jr. Read before the Am. St. Ry. Assn. Shows the growing need of the best signal system possible, and discusses the requirements. 1700 w. St Ry Rev—Oct. 11, 1902. No. 51189 C.

**Stray Currents.**

The Electrolytic Action of Currents upon Buried Pipes (Ueber den Elektrolytischen Angriff Elektrischer Ströme auf Eisenröhren in Erde). A. Larsen. A review of experiments made upon buried iron pipes at the Technical High School of Copenhagen. 1200 w. Elektrotech Zeitschr—Sept. 18, 1902. No. 51352 B.

The Prevention of Electrolysis of Gas and Water Pipes in Great Britain. A review of steps taken by the British Board of Trade, presented by W. H. Humphreys at the recent meeting of the Brit. Assn. of Water-Works Engrs. 1700 w. Eng News—Oct. 2, 1902. No. 50928.

The Prevention of Electrolysis by Periodical Reversal of Current (Ueber Periodische Stromwendung als Mittel zur Verringerung Elektrolytischer Zerstörungen). A. Larsen. Data and results of experiments showing that electrolytic corrosion of buried pipes may be greatly diminished by daily or hourly reversal of the flow of current. 1500 w. Elektrotech Zeitscht—Sept. 25, 1902. No. 51358 B.

**Surface Contact.**

The "Dolter" Surface Contact System. A review of a book giving an illustrated detailed description of this system. 2800 w. Elec Rev, Lond—Sept. 19, 1902. No. 50852 A.

**Tracks.**

The Construction of Perfect Track. Two short papers by J. C. Brackenridge and R. Trimble, with general discussion. 11000 w. N Y R R Club—Sept. 18, 1902. No. 51123.

Track Construction and Maintenance on the Detroit United Railway. Illustrated article describing methods and machines used in constructing and maintaining about 188 miles of city track and 192 miles of interurban track. 3000 w. St Ry Jour—Oct. 4, 1902. No. 50978 D.

**Tramways.**

Procedure on Application for a Tramway Order. Outlines the procedure which must be observed by those who promote an electric tramway in England or Wales. 1400 w. Elec Rev, Lond—Sept. 26, 1902. Serial. 1st part. No. 50959 A.

**Transfers.**

Registration of Transfers. C. D. Meneely. Read at Detroit meeting of the St. Ry. Con. Outlines the arguments for and against the registration of transfers with a view of determining evidence from which to draw a conclusion. 1500 w. St Ry Jour—Oct. 11, 1902. No. 51146 D.

**Trolley Wires.**

Trolley Wires of Special Section (Der Profil draht). Max Schiemann. A discussion of the so-called "hour-glass" section and other special shapes for trolley wires, with regard to the methods of supporting, joining, and protecting them. 1500 w. Elektrotech Zeitschr—Sept. 18, 1902. No. 51353 B.

**Trucks.**

Trucks for Interurban Service. C. F. Uebelacker. Gives the conditions to be met by a truck intended for high-speed service, and gives illustrated descriptions of various types. 4200 w. St Ry Jour—Oct. 4, 1902. No. 50989 D.

**Tyneside.**

The Tyneside Tramways and Tramroads. Brief illustrated description of this recently opened line. 3400 w. Elec Engr, Lond—Oct. 3, 1902. No. 51074 A.

# EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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## THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

# CURRENT RECORD OF NEW BOOKS

**Note**—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* The Engineering Magazine.

**Cuba.**

Report of Major W. M. Black, Corps of Engineers, U. S. A., Chief Engineer Department of Cuba. Volumes XI and XII of the Civil Report of Major General Leonard Wood, Military Governor of Cuba. Size, 9½ in. by 6¾ in.; pp. (Vol. XI.) 264, (Vol. XII.) 425; maps and illustrations. Paper binding.

These reports cover respectively the fiscal year ending June 30, 1900, and the six months ending Dec. 31, 1900. They are couched in the formal language of government documents, but their unadorned record of work performed is wonderfully impressive. The reports cover the whole of Cuba, and describe a great variety of engineering and sanitary work, including pavements, sewers, parks, harbor improvements, water-works, hospitals, prisons, etc. Amid difficult and trying circumstances, the United States army engineers have performed their task with wisdom and fidelity, and with the most satisfactory results. No Cuban can read this straightforward account of the renovation of the Pearl of the Antilles without a feeling of gratification, and no American without a sense of pride.

**Framed Structures.**

The Mechanics of Engineering. Vol. II. The Stresses in Framed Structures, Strength of Materials and Theory of Flexure; Also the Determination of Dimensions and Designing of Details, Specifications, Complete Designs and Working Drawings. By A. Jay DuBois, C. E., Ph. D. Size, 11 in. by 8 in.; pp. XXIII, 609; figures, 300; plates, 50. Price, $10. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

This is the twelfth revised edition of "The Stresses in Framed Structures," by the professor of civil engineering in the Sheffield Scientific School of Yale University, and, although issued as Vol. II of "The Mechanics of Engineering," is complete in itself. This work is a very complete exposition of the theory and practice of the design of bridges and other framed structures. In the present edition the "principles of least work" has been successfully applied to the solution of many problems, including those of the continuous girder, the swing bridge, the arch and the suspension bridge. There are given general specifications for steel railroad bridges and viaducts, by Theodore Cooper, and a list of the different members in a bridge, by Prof. J. A. S. Waddell. There is a chapter on modern high buildings by William W. Crehore, and one on erection, by J. S. Deans. The volume is profusely illustrated, and is of great value both as a text book for the engineering student and a work of reference for the professional engineer.

**Gas Testing.**

Gas Analyst's Manual (Incorporating F. W. Hartley's "Gas Analyst's Manual" and "Gas Measurement.") By Jacques Abady, M. Inst. Mech. E. Size, 9 in. by 6 in.; pp. XV, 561; illustrations, 102; tables. Price, $6.50. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain.

This is a very complete treatise on the testing of illuminating and heating gas, written from a British standpoint. Besides the testing of the gas itself, tests for all the materials entering into the manufacture of gas are described. Though founded on the works of the late F. W. Hartley, as mentioned in the title, this volume has been amplified to have a far wider scope, and Mr. Hartley's books are incorporated in only three chapters and occasional paragraphs. In the present volume, there are chapters on photometry; standards of light; calorimetry and specific gravity; tests for sulphur and ammonia; coal testing; testing of enrichment and purification materials; quick gas-works tests; testing of bye-products; technical gas analysis; and meter and governor testing. An appendix contains many useful tables and data. The book is handsomely made and bound, and is altogether a most comprehensive manual of testing for the gas-works engineer.

**Gearing.**

Worm and Spiral Gearing. By Frederick A. Halsey. Size, 6 by 3¾ in.; pp. 85; figures, 23. Price, 50 cents. New York: D. Van Nostrand Company.

This is one of the Van Nostrand Science Series, and reprinted from the "American Machinist," of which the author is associate editor. The theory of the efficiency of worm gearing is laid down, and the advantage of a large angle of thread is clearly shown. This theory is supported by facts drawn from experience, and it points out clearly the procedure to be followed in order to insure durability and efficiency. In the second part of the work, both analytical and graphical methods of laying out spiral gearing are given, and the subject is ably discussed.

**Industrial Conciliation.**

National Conference on Industrial Conciliation, Under the Auspices of the National Civic Federation, Held at Rooms of Board of Trade and Transportation, New York, December 16 and 17, 1901. Size, 7½ by 5 in.; pp. 278. Paper binding. Price, $1.25. New York: The Knickerbocker Press (G. P. Putnam's Sons).

Part I of this book consists principally of a complete stenographic report of the above conference, including addresses by leading representatives of capital, of labor and of the general public. There are also a list of the industrial committee, appointed after the adjournment of the conference, consisting of 36 members representing the public, the employers and the wage earners, and this committee's "statement of purpose." Part II contains the more important papers read at the Chicago conference of the National Civic Federation, held on December 17 and 18, 1900. Appendix I has the "Appeal to the American People," adopted at the Chicago conference, and Appendix II is the address of this conference's National Committee on Conciliation and Arbitration, issued May 8, 1901, at New York. On the whole, this little volume gives a clear view of one of the most notable attempts that has been made to get "capital" and "labor" together and make them understand each other, so that they will see that their true interests are not conflicting, but harmonious.

**Shipyard.**

Cramp's Shipyard, 1830-1902. Size, 8 by 5½ in.; pp. X, 180; illustrations, 26. Philadelphia: The William Cramp & Sons Ship and Engine Building Co.

This book is printed for private circulation by the great shipbuilding company which has had so large a share in creating a new navy for the United States. It contains a brief history of the business which was founded on a modest scale by William Cramp in 1830, and which has since grown to such enormous proportions. There are beautiful illustrations and descriptions of the more important of the 321 sea-going vessels of all classes which have been built in Cramp's shipyard, including United States, Russian, Japanese and Ottoman men-of-war. The volume is elegantly and tastefully made in every respect, and is an appropriate epitome of a great enterprise.

**Timber.**

Timber. A Comprehensive Study of Wood in all its Aspects, Commercial and Botanical. Translated from the French of Paul Charpentier by Joseph Kennell. Size, 10 by 6½ in.; pp. 437; illustrations, 179. Price, $6. London: Scott, Greenwood & Co. New York: D. Van Nostrand Company.

This book covers broadly the whole timber field, starting with the growing tree and carrying the history of wood down to the point where it is ready for the multitudinous uses to which it is put. Divisions of the book are devoted to the physical and chemical properties of wood; description of the different species of wood; the useful varieties of timber in the different countries of the world; forests, their improvement, preservation and exploitation; the preservation of timber, including fireproofing; and the applications and products of timber, this last part including building timber, paving wood, mine timber, railway cross-ties, gums, resins, bark, tanning materials, cork, dyewoods, oil of wood and miscellaneous wood products.

**Wood Turning.**

A Manual of Wood Turning. By C. R. Richards, M. M. E., Professor of Mechanical Engineering at the University of Nebraska. Size, 13 by 12 in.; pp. 20; figures, 64. Price, $1.00. Lincoln, Neb.: The University Book Store.

This manual presents in a concise manner the methods employed in the turning of wood. In order to best adapt it for use in the college shop, where a treatise in book form would be inconvenient, it is printed on separate large sheets, on only one side of the paper. These sheets are perforated so that they can be kept together in a cloth binder. After describing a wood lathe and the tools in general use, a number of exercises are taken up and detailed directions for properly executing them are given. The exercises have been used in practical instruction for many years, and the whole manual has a very workmanlike look and is peculiarly adapted to the needs of mechanical engineering students.

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## BOOKS ANNOUNCED.

Twenty-Third Annual Report of the Ohio Society of Surveyors and Civil Engineers. W. H. Boughton, Secretary and Treasurer, Granville, Ohio.

American Municipal Progress. By Charles Zueblin. Size, 7½ by 5 inch.; pp. 380. Price, $1.25. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

Le Béton Armé et Ses Applications. 2d ed. By Paul Christophe. 8vo; 847 figures. Price, 25 francs ($7.50). Paris and Liège: Ch. Béranger.

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# LAKE BOHIO
# THE SUMMIT LEVEL OF THE PANAMA CANAL.

*By George S. Morison. With an Editorial Introduction.*

As Member of the Isthmian Canal Commission, Mr. Morison gave particular attention to the Panama Canal route and the several proposed Darien lines. With his pre-eminent rank as an engineer and this intimate familiarity with the special problem under discussion, he is easily a foremost authority upon what might, perhaps, be termed the American plans for the great waterway. His article following is primarily an answer to the argument for the "two-lake" projet of the *Comité Technique*, so earnestly supported by Gen. Abbot in our preceding issue. In effect it is more—it is a brief statement, admirable for its conciseness and sufficiency, of the Isthmian Canal Commission's solution of the two great problems of the work. How different was their position from that of the French engineers in approaching the study—how much greater their freedom to consider the problem as a whole—Mr. Morison explains clearly. In the light of his discussion, one suggestion of our editorial introduction to Gen. Abbot's paper must be withdrawn—that is, that the Commission felt itself too limited as to time for a decision upon working plans. The projet outlined by Mr. Morison is not merely sufficient for comparative estimates, but, in the Commission's opinion, best for the building of the Panama Canal. THE EDITORS.

THE Panama Route was selected more than twenty years ago by the Congress of Paris as the best location for a canal across the American Isthmus. The wisdom of this selection has been confirmed by the Isthmian Canal Commission, which advised the selection of the same route as the one best adapted for a canal to be built by the United States Government. The Panama Route does not have the lowest summit and it is not the shortest line. The lowest summit is on the Nicaragua Route and is nearly 150 feet lower than the natural summit at Panama. The shortest route between the two oceans is the San Blas Route which is nearly 10 miles less than the Panama Route. But the Nicaragua Route, in spite of its low summit, is four times as long between oceans as the Panama Route, and the San Blas Route with its short distance has a summit four times as high as the summit at Panama. There is no single feature of the Panama Route which is not inferior to a corresponding feature of some other route. On the other hand, there is no route in which the worst feature is not a great deal worse than the corresponding feature at Panama. After balancing all the Panama Route comes out ahead. The two serious features of the Panama Route are the control of the Chagres River and the summit cut at Culebra. Each of these permits of an entirely satisfactory solution and when the work is completed no further difficulties are to be anticipated from either. In considering the best plan for a canal these two constructive features must be taken together.

The study of the Chagres River, which was made by the New Panama Canal Company from records collected at the Isthmus and collaborated in Paris, has been of an exhaustive character and of the greatest value. The results of this study are embodied in the article in the December number of the ENGINEERING MAGAZINE by Gen. Henry L. Abbot who, as a member of the *Comité Technique*, was especially selected to develop the results of these observations. The principal features of the article were presented to the Isthmian Canal Commission in Paris in 1899, since which time the records of three years have been added, the full benefits of which are now given. The conclusions of Gen. Abbot as expressed in this article, giving the leading features of the discharge of the Chagres, may be accepted as the latest and most complete information on the subject. They differ from the data used by the Isthmian Canal Commission only in being in greater detail and somewhat less extreme both in maximum and minimum amounts, the Commission having selected a minimum discharge somewhat less than any observed minimum and provided for a maximum somewhat in excess of any calculated maximum.

The conclusions of Gen. Abbot may be briefly stated. The maximum flood in the Chagres occurred in 1879 and produced a discharge of 78,614 cubic feet per second at Gamboa, which is approximately the point where the canal leaves the Chagres valley to cross the divide, and of 112,730 cubic feet per second at Bohio where the dam across the Chagres would be located. Gen. Abbot estimates that this flood discharge at Bohio may have averaged 104,600 cubic feet for 37.3 hours. The next greatest flood occurred in 1888 and amounted to 79,000 cubic feet at Bohio and to 64,488 cubic feet at Gamboa. The conclusions of the Commission were that the canal should be so designed that a flood representing a discharge of 75,000 cubic feet per second at Bohio would not interfere with navigation and that a flood of 140,000 cubic feet per second would do no permanent injury to the canal. The accommodation of floods of this magnitude is simply a question of size of channel. The Commission adopted a speed of three feet per second, about that of the Detroit River in front of the city of Detroit, as the limit which would not disturb navigation, and about twice this speed as the limit which would not injure the works of the canal. The minimum average discharge of the Chagres in any month at Bohio occurred in April, 1901, when it averaged 565 cubic feet per second.

If a tide-level canal were to be built the Commission was of the opinion that it would be necessary to hold back the floods of the upper river by impounding them in a lake above a dam at Alhajuela and to make the canal, which would necessarily be in the lowest part of the valley, of such dimensions that it would safely carry off the remainder of the flood. If, however, a high-level canal were adopted, the area of the channel everywhere could easily be made adequate to take the entire discharge of the Chagres at a speed which would not even interfere with navigation. It was also manifest that the higher the level of the lake, the larger would be its cross section everywhere and this relative increase would be greatest in the most constricted places. Furthermore, as it was considered important to make the lake the summit level of the canal, the height of this lake fixed the depth of the great Culebra cut, the importance of which is manifest from the fact that each foot of increased depth of cut represents more than 300,000 cubic yards of excavation, with a corresponding expenditure of money and, what is more important, of time in the completion of the work.

The Commission adopted a height of 90 feet above mean tide and five feet above the crest of the spillway, as the maximum level for Lake Bohio; this is about 18 feet higher than the level selected by the French engineers and recommended by Gen. Abbot. This change represents a corresponding increase of depth of water in nearly the whole area of Lake Bohio and a reduction of something like 6,000,000 cubic yards of excavation in the Culebra cut.

Besides increasing the depth and area of the lake, and thus facilitating navigation, this change extended the lake up the valley of the Chagres nearly to the site of the proposed Alhajuela dam, this extension of lake having one advantage of which little has been said. The upper Chagres is a clear mountain stream with rocky banks and rapids over coarse gravel or boulders. It shows no sign of silt and there need be no fear of its bringing down material which would cause sandbars and deposits below. A few miles below Alhajuela the character of the banks changes, and fine material is found which is washed away during freshets and produces silt and sandbars below. With the lake at the higher level all this soft material would be perpetually submerged in positions where there would be little danger of washing, and the amount of silt brought into the lake would be very greatly diminished.

The only objection that can be raised to this increased height of lake is the additional lockage required to approach it in each direction, and the additional height of dam.

As to the first objection, the plan of the Commission involves no more locks on the west side than the plans of the French Company, and the lifts of these locks do not exceed the lifts proposed by the French engineers for the locks on the east side. On the east side the plan of the Commission proposed locks of the unusual lift of 42 feet; that such locks are practicable no engineer will deny. If, however, it is thought important to keep the lift down to the limit of about 10 meters, adopted by the French engineers, it is perfectly possible to use three locks instead of two, two of the three to be located at the Bohio site and the third lock either at Peña Blanca or at Tiger Hill as will be explained hereafter.

So far as the dam is concerned the maximum height selected by the French engineers seems to have been adopted on a purely arbitrary basis. With some modification in dimensions and construction a dam 90 feet high will be as safe as a dam 70 feet high. The head of water against the dam can be reduced by raising the level below as well as by reducing the level above, and if a third lock is used the level below will be raised so that the head against the dam will not exceed that contemplated by the French plans. Moreover, while the author is convinced that the amount of seepage under the dam will be insignificant even with the increased head, there are various ways by which the flow of water through any permeable material below the present bed of the Chagres can be cut off, some of which methods would not involve an unreasonably large expenditure.

The French plan proposed to limit the amount of water which should be admitted into Lake Bohio from all sources at any time to about 33,000 cubic feet per second. The discharge was to be taken over two spillways, both regulated by systems of sluices, through diversion channels on each side of the canal, to the sea, while the control of the lake was also to be handled through regulating works in connection with the upper dam at Alhajuela. Apparently the ability of the diversion channels below to carry off the discharge was the principal measure which limited the supply of water to be admitted into the lake at any one time. The scheme was very carefully worked out and there is no doubt that it would be effective. The Commission, however, considered it unnecessarily complicated and it involved a personal element in the working of the sluices which it was desirable to avoid. It was necessary not only to regulate the height of the water in the two lakes as floods increased, but to apportion the discharge of Lake Bohio between the two separate diversion channels.

The surveys made by the New Panama Canal Company revealed the fact that near the head of the Gigante, a small tributary of the Chagres above Bohio, there was a gap at an elevation 65 feet above tide water, through which the overflow of the lake could be taken into the lower valley of the Chagres. This was a comparatively late discovery, but the location was at once adopted for one of the two spillways. The beauty of this location for a spillway was its distance from the dam and the line of navigation, while borings showed a good rock bottom on which a masonry structure could be founded. The area of the lake is about 1,000,000,000 square feet. Calculations showed that a fixed spillway 2,000 feet long at this place would carry off a discharge of 80,000 cubic feet per second, with the water five feet above the crest of the dam, and a discharge exceeding 100,000 cubic feet with the water six feet above the crest. With such a spillway the regulation of the lake would become entirely automatic. It would be the simplest kind of a hydraulic problem. During any period of excessive rainfall, no matter how long continued, the waters of the lake would rise until the flow over the spillway equaled the flow into the lake. When the excessive rains were over the lake would continue to fall until a condition of equilibrium was reached again. Except during extreme floods the discharge from the lake would seldom maintain the water more than a foot above the crest of the spillway; a rise of four feet in 18 hours would represent an average storage in the lake of 23,000 cubic feet per second; a flood equal to that of 1879 would probably never involve a discharge of over 80,000 cubic feet per second over the spillway. But even if an extreme flood beyond all precedent and of indefinite duration should occur, it would simply mean a slight further elevation of the surface of the lake; there is a large margin for safety and ignorance. The absolute simplicity and automatic character of this arrangement made it one of the most satisfactory solutions of a hydraulic question which has ever been reached. The channels in the more constricted portions of the lake are abundantly adequate to take care of the flow of water. The spillway is abundantly large to carry off any discharge.

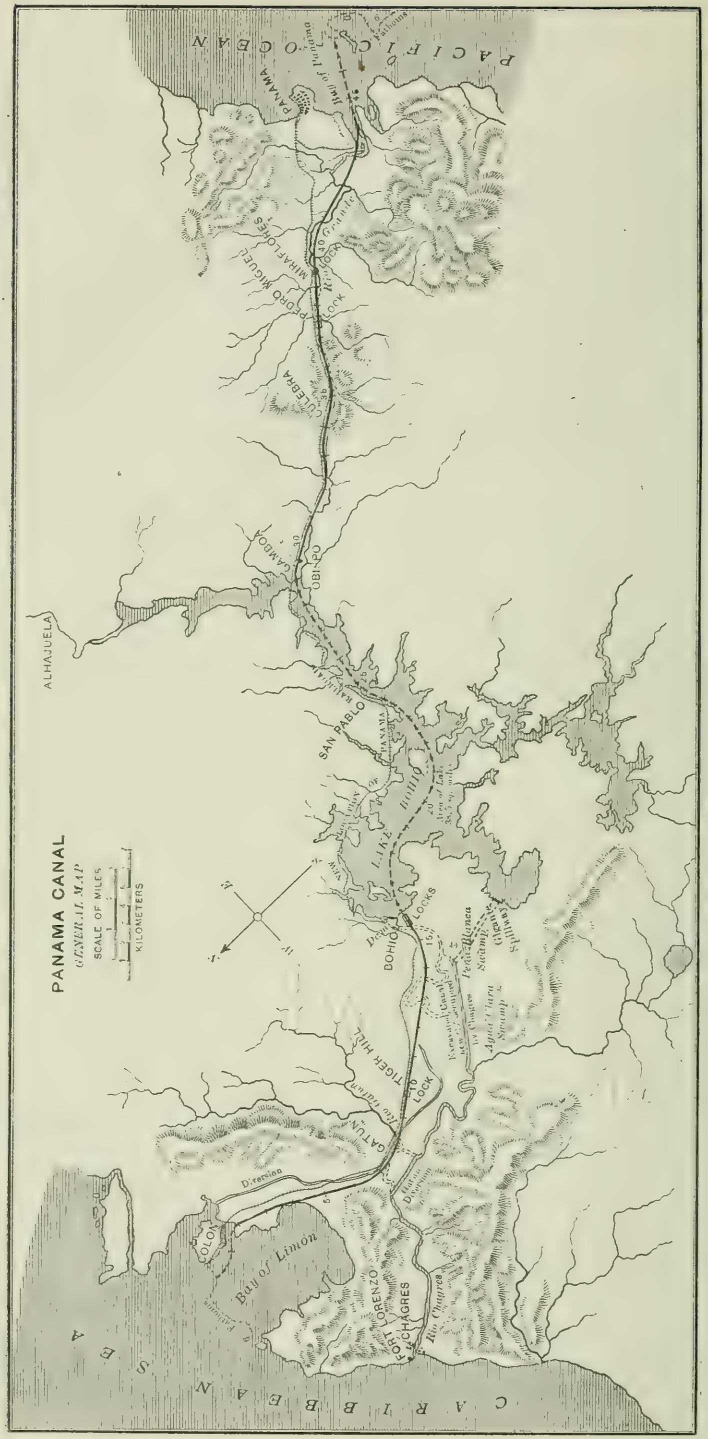
There remain but two problems. The first is the supply of water during the dry season when the discharge of the river is not adequate. The actual demands of the canal for lockage, leakage, evaporation, and all other usual requirements are not far from 1,000 cubic feet per second. The actual deficiency in any one year would be less than 3,000,000,000 cubic feet. The plan of the Commission contemplated making the channel through the lake and the summit cut sufficiently deep to allow the lake to be drawn down three feet to supply this deficiency of water. There are other means of supplying it. It is not improbable that the wisest course would be to build the upper dam at Alhajuela and provide for this additional storage in an upper lake; in the writer's mind the principal reason for doing this would be to reduce the depth of excavation through the Culebra cut.

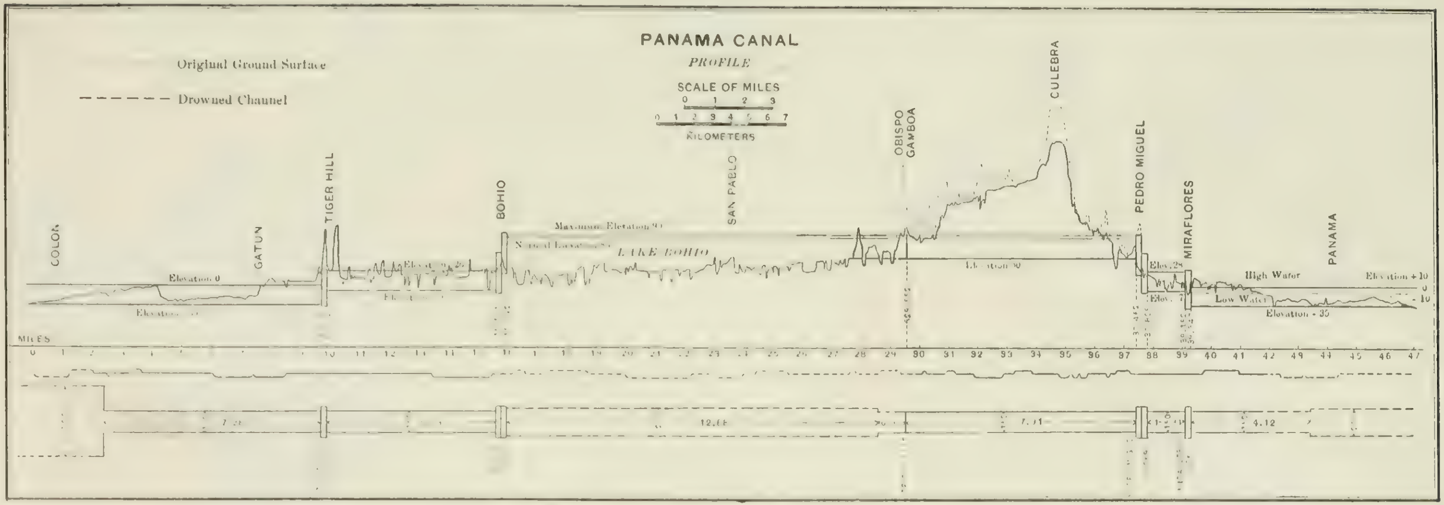
The second problem is the disposal of the water after it has left the spillway. The location of the Lesseps tide-level canal followed the lowest portion of the valley of the Chagres and this canal was supposed to be completed to within two miles of Bohio. It crossed the Chagres several times and for a length of about three miles the canal excavation has become the main channel of the river, which has abandoned its more circuitous natural course. The spillway is about four miles from the navigable channel in Lake Bohio and more than two miles from the canal below the locks. The canal continues in this low country to Gatun, from which point it bears northerly to Colon while the Chagres River flows westerly to its mouth. A series of swamps lie between the line of the canal and the hills. The discharge over the spillway would be taken through these swamps and would be kept out of the canal by a series of levees made of material excavated from the bed of the canal. At Gatun, however, the course of the canal crosses the Chagres and the valley between the hills is contracted.

At this point it would be necessary to cut a large deep channel across the peninsula made by a bend of the river and at a safe distance from the canal, through which the floods would be diverted. This diversion channel, with the aid of a channel between two of the swamps and the protection of the levee on the exposed side of the canal, would send the maximum discharge of the spillway safely to the sea.

There is another solution of this problem which would probably be less costly and which the writer prefers. This scheme was regarded with favor by the Isthmian Canal Commission and a survey was made of the line it would follow, but it was considered premature to adopt it for the estimates of the Commission's report. It contemplates keeping east of the lowest part of the valley, following substantially the route of the Panama Railroad from Bohio to Gatun where it would join the French location. This line would save a mile and a quarter of distance and would leave the present canal and the lower valley of the Chagres entirely free to take the discharge of the spillway. Furthermore, at Tiger Hill there is an excellent site for a lock and the canal could be carried on an intermediate level, about 26 feet above tide water, from the Bohio locks to this point, thus reducing the lift of the Bohio locks and the head of water against the dam. If this line was adopted the discharge from the spillway would nowhere come within half a mile of the canal, and then only through the deep channel opposite Gatun where it would be defended by rocky banks. For much of the length the canal would be carried at a level safely above any possible discharge. This route is shown on the map and the profile which accompany this article.

Comparing the plan adopted by the New Panama Canal Company with that recommended by the Isthmian Canal Commission the very different circumstances under which their work was done should be remembered. This difference lies not so much in the time available for study as in the general problem which each had to consider. The French Company found itself with an unfinished property on which enormous sums had been expended, which was worse than useless in its present condition, and which could be saved only by completing it in the shortest possible time and with the least possible expenditure of money which was yet to be obtained. So marked were these conditions that the plan advocated by Gen. Abbot, of two lakes the level of the lower and larger of which was to extend through the Culebra cut, was rejected in favor of a plan in which the summit level was placed 45 feet above this lake and reached from the lake by a flight of two locks, while a feeder of complicated and difficult construction

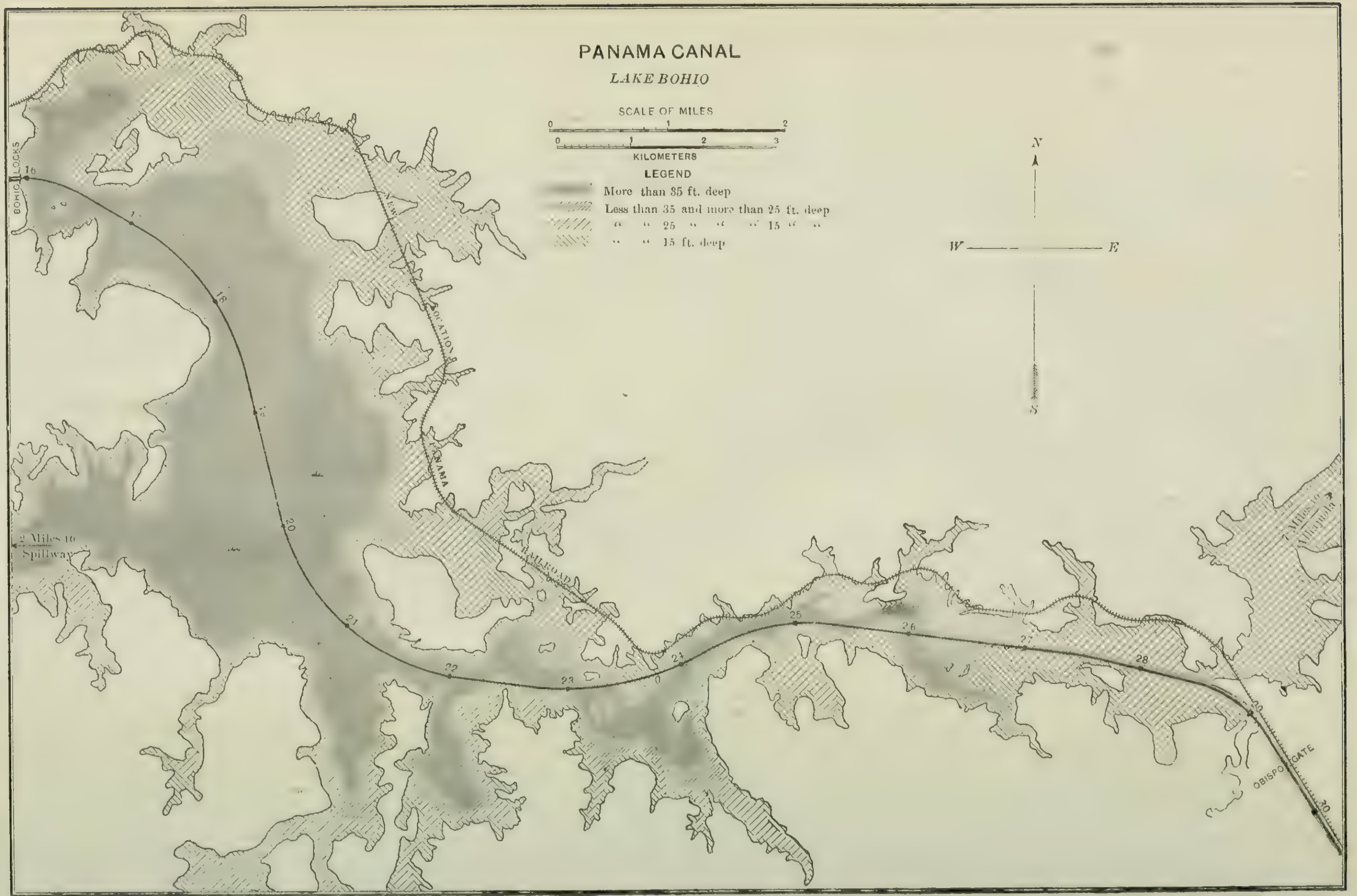

PANAMA CANAL
GENERAL MAP
SCALE OF MILES
KILOMETERS
N
E
W
PACIFIC OCEAN
Bay of Panama
PANAMA
MIRAFLORES
PEDRO MIGUEL
LOCK
LOCK
Rio Grande
CULEBRA
GAMBOA
OBISPO
ALHAJUELA
SAN PABLO
RAILROAD
PANAMA
LAKE BOHIO
BOHIO
LOCKS
TIGER HILL
Rio Gatun
GATUN
LOCK
Diversion
COLON
Bay of Limon
FORT LORENZO
CHAGRES
Rio Chagres
Peña Blanca Swamp
Gigante Spillway
Agua Clara Swamp
Excavated Canal
CARIBBEAN SEA



MAP AND PROFILE OF THE PANAMA CANAL ACCORDING TO THE PROJET OUTLINED IN THIS PAPER.

In the map above, the canal proper is indicated by a full line, the drowned channels by broken lines. The scale of the map is too small to show the topography around the lake which is everywhere surrounded **by high hills.**

In the profile below, the irregular line below the scale of miles indicates the alignment. The width of the canal is indicated below this; attention is called, however, to the fact that the drowned channel in Lake Bohio is really only a theoretical channel, the lake being very much wider.



This map gives the depth of water at normal stage, that is, when the level of the lake is that of the crest of the spillway. During floods the depth would be increased by the height which the lake is raised by the passage of water over the spillway. Attention is called to the two steamers shown at anchor.

was provided to supply the summit level from the upper lake above the Alhajuela dam. This plan was but little less costly than the plan which made the lake the summit level, but was adopted because it was thought that it could be completed in two years less time. The French Company adopted a bottom width generally of about 100 feet and a depth of nine meters, about 29.5 feet, but in the portion of the canal through the low country north of Bohio the plans showed the original dimensions adopted more than twenty years ago by Lesseps with a bottom width of 72 feet. It was also impressed with the value of the work already done and felt it necessary to use as much of it as was possible. The Isthmian Canal Commission had a different problem; the canal must be the one best adapted to the demands of commercial and military service. The depth was increased to 35 feet, the bottom width to 150 feet, and the greater the amount of free navigation with broad channels the better. Instead of using the old channel of the contracted Lesseps dimensions between Bohio and Colon, its plans were based on full dimensions here, although this enlargement involved the removal of a very large portion of the spoil banks deposited when the original excavation was made, and made the amount of work to be done here almost as great as if nothing had ever been done. The Commission felt less bound by the value of old work, discarded partially completed diversion channels which did not appear to be in the best location, and generally endeavored to get the canal which would be most satisfactory when done within reasonable limits of time and cost.

The Commission's plan lends itself to the opening of the canal before it is completed in its entirety. Much of the structural work can be deferred until the canal is actually put in service. The Gigante spillway, the Bohio dam, and the diversion channel west of Gatun must be completed. All the locks are in duplicate, and the construction of the second lock can be postponed till after the opening of the canal. The provision for additional storage of water to supply the waste of the dry season can also be deferred.

In one important respect the French Company and the Commission were guided by the same idea; they both felt that is was necessary to complete the canal as early as could well be done, and to accomplish this the depth of the Culebra cut must be reduced as much as possible. The method adopted by the French Company to accomplish this end was the higher summit level through the cut. The method adopted by the Commission was to raise the level of Lake Bohio. The original Lesseps plan was for a sea-level canal. This plan was rejected by the new French Company for three reasons; the difficulty of controlling the Chagres, the great cost of the Culebra cut, and the time required for its construction. It was also rejected by the Commission, which felt that the Chagres could be handled even with a tide-level canal, that the cost of the excavation was not enough to be prohibitory, but considered the time required to complete such a canal so great as to outweigh all other considerations.

The advantage of the interior lake is not merely the control of the Chagres and the water supply of a summit level; it will be a great aid to navigation. The total area of the lake it about 40 square miles, of which 10 square miles are more than 35 feet deep at normal stage and more than 40 feet deep during times of extreme flood. This lake is shown on the accompanying plan. It forms an interior harbor nearly as large as the upper bay in New York Harbor, and will have all the advantages of a fresh-water anchorage which have been ascribed to Nicaragua while it is not so large as to be troubled by the waves which limit the anchorages of its larger rival to the more protected localities. The plate shows two steamers at anchor in Lake Bohio, one of them as large as the Oceanic, which give some idea of the available room. In many ways the existence of this lake is an important advantage which would be lost in a tide-level canal. It is about equally distant from the Caribbean Sea and from Panama Bay. It will be the natural meeting point for steamers. The whole transit will consist of two canals and an intermediate lake, all three of about equal length. The passage through each canal, including the locks, will take from four to five hours; the passage of the lake one or two hours more. Ships starting from either terminus in the early morning will meet in the lake, and pass out into the further ocean at twilight. Ships starting at noon will probably spend the night in the lake and proceed in the morning.

While the author does not believe that the Alhajuela dam will be needed during the early years of canal operations, and considers that with a lake of the enlarged dimensions adopted by the Commission it will never be required for the purpose of controlling floods, he does think that the upper lake will prove the most economical and satisfactory method of storing the reserve water which will be required for use during the low-water season as traffic through the canal increases. His own studies have confirmed the conclusions of Gen. Abbot, "that all the water that can ever be demanded by any probable traffic" can be obtained from the Chagres, even though the traffic is several times the 23,000,000 tons suggested as a maximum.

# FREAKS AND FALLACIES IN STEAM-ENGINE DESIGN.

*By Egbert P. Watson.*

Mr. Watson's long experience in the field of steam engineering has covered a considerable portion of that wonderful advance which was recently reviewed in these pages by Mr. W. M. McFarland, in his series on "The Growth of Economy in Marine Engineering." In the following article Mr. Watson takes up some of the false steps by which ignorant or dishonest inventors have strayed from the true line of advance.—THE EDITORS.

THE work of the world is practically done by one type of engine—a circular disk piston working in a cylinder, driving a shaft through the media of cranks and connecting rods. I have, perhaps, been needlessly explicit in specifying a circular piston, but in view of the fact that there are, or have been, many kinds of pistons for steam engines, it is not improper to designate the one which experience and precedent have found to be the most suitable. Many years ago (1844) Captain John Ericsson designed and built engines for the United States steamer Princeton; these had pistons rectangular in profile which worked in a semi-cylinder, the same as a door swings on its hinges. Not very long ago I saw an engine with a piston which was hemispherical, bisected in a plane obliquely to its normal axis; I say piston, but this was really only a portion of it, for there was a further detail consisting of two vanes working through slots in the hemisphere that received the actual pressure of the steam. Square pistons reciprocating in square cylinders have also been constructed, and pistons which were a section of an annulus, reciprocating in annular cylinders. But the engine which has done the principal work of mankind—at least up to the present period marked by the promising advent of the steam turbine—is of the type described at the beginning of this article, and its adoption has not been dictated by fancy or the whims or notions of manufacturers, but simply by the fact that it has given the highest efficiency known. That is to say, a given weight of steam in a reciprocating-piston engine, with a circular piston, has given the most power for the least expenditure.

This knowledge has been dearly bought, for men in all ages, from the first inception of the steam engine, have worshipped strange gods in its likeness, only to find that they had wandered far from the truth.

I might call these departures "freak engines" because they are curious examples of aberrancy in the general type, not from any desire to belittle the efforts of ingenious designers. I willingly admit that they show ingenuity of a certain kind, but I must add that it is misplaced. It is no particular advantage in the majority of cases for a steam engine to be capable of exerting a horse power in half the space usually occupied by such machines; there is "room and verge enough" in ninety-nine cases out of a hundred for all the power required for manufacturing. For marine purposes an exception may be taken to this statement, but it will be found, in almost all cases, that the claims made for compactness are wholly dissipated when the efficiency of each type is measured and the power developed is weighed in the balance. That is to say, the respective powers of the reciprocating engine and the freak engine are in no wise comparable, all other defects and disadvantages being ignored. One of the first announcements made on the advent of a new freak engine is that it has no dead center, no piston rod or cross head, no valve gearing, and requires no engineer, etc.; it might be added that it has no power, or not what it should have for the steam it demands. If this serious defect be ignored by equipping the vessel it is in with an abnormally large boiler, there is no buoyancy and neither passengers nor cargo can be carried. The whole procedure with freak engines is an effort to harmonize radical defects of design and principle with established facts and precedents, and after experimenters have spent all the funds they can beg or borrow, they begin to realize that they are on the wrong train.

In this direction, the wasting of money in futile experiments, I have seen some astonishing instances. It would be impolitic to mention specific cases of the character indicated, but a general reference to one which occurred but a few years ago is not improper. An inventor conceived the idea of a new steam engine which was to revolutionize the business (they never do less than this) and he proceeded to put his ideas into practical form. He was not a machinist, certainly not a mechanic. He overcame this difficulty by engaging assistants who had the necessary qualifications but were not experienced in steam engineering. The result of the combined talent of the staff was a machine quite unlike anything ever known before, and its very uniqueness and impossibility as a steam engine seemed to convince all concerned that they had made a great discovery. They were so certain of this that they went into the manufacture of the engine at once upon a large scale, without even demonstrating its practicability for any purpose whatever, the designer being able to command a long purse—not his own, but that of another individual who had so much money that he did not know what to do with it. Large modern shops were constructed, and, as there were no tools known to the machine trade which would do the work upon the details, special machines that were useless for any other work were invented also. These tools were exceedingly large and heavy; being wholly new in character, all patterns and fixtures had to be made for them also. This expenditure, be it remarked, was undertaken prior to any knowledge of the possibilities or defects of the principle (if there was one) of the engine, and not one alone of one kind was made, but machines were designed for all possible uses likely to be encountered. I cannot, without giving a clue to this particular enterprise, describe these machines, but nothing more bizarre or absurd in the line of sane machine-designing was ever made before. I have had a tolerably wide experience in this direction in various parts of the country, and when I went through these shops I could not believe that any one connected with the enterprise—except the originator of it—had the least idea that the scheme was plausible, to say nothing of being practicable. I must add that not only were various kinds of machines designed, but several of each type were installed, and there they stood in long rows on the floor, melancholy instances of the fatuity of man when he once gets a wrong sheer.

When a general knowledge of this adventure was made known through the technical press the originator of it was kindly advised that his engine was a monstrosity of engineering and totally useless for the purpose he intended it, but these warnings did not deter him in the least from following his plans to the bitter end of total failure; just how many hundreds of thousands of dollars were spent upon this particular freak was not made public, since it was a private loss with which the public had no concern. It is not an isolated instance by any means, and not the least objectionable feature of such enterprises is the ruin of persons of small means who invest all their money in them when florid announcements of their great value are advertised all over the land, in just such exaggerations as the press dispatch here quoted from a late issue of a daily paper.

> "After working through several years of discouragement, success has at last come to the inventor of a certain device. He has received word from George W. Melville, chief engineer of the United States Navy, that it has been accepted by the United States Government and he has assurance that it will be put in use by European powers.
>
> "The machine was the winner of a competition authorized by the Government for oil burners that could be used to increase the speed of war vessels.

> Blank's apparatus claims superiority in the fact that it does not burn oil directly, but, by the infusion of steam and hot water, the oil is converted into a gas, which, while yet hot, is fed to the fire.
>
> "It is asserted that this increases the amount of heat ten times and it is said that battleships equipped with this burner may increase their speed by four or five knots per hour."

Readers of THE ENGINEERING MAGAZINE do not require to have the absurdities of this paragraph pointed out to them, but men who read the newspapers with a view to investing in schemes which will make them rich quickly too often act upon such wild statements. Just here is a remarkable feature of freak-engine enterprises—the avidity with which an impossible scheme is absorbed by financial confederates. A list of the promoters and stockholders, sometimes published, reveals the names of unknown individuals ostensibly backing and promoting it, but if these persons are looked up and demand is made for their personal knowledge of it, not one of them can or will say anything that has a bearing upon its actual commercial value, or soundness from an engineering point of view. They willingly assert that they "think" it is a good thing, especially the dummy stockholders who have been promised shares for the use of their names; but none of them can be held responsible for his statements.

Some years ago I was present at a visit of a prospective investor in one of these engineering fallacies, having strolled in to look at the thing from curiosity. The promoter was present in person, and the prosperous-looking investigator was at once pounced upon by him. He first pointed out the steam gauge, which showed a pressure of only 10 pounds, and said that the gentleman could see for himself that it was a very low-pressure engine; where other makers had to have ten times the pressure, his would run with far less and give out greater power. To demonstrate this assertion he took a piece of waste in his hand and bore down heavily upon the periphery of the flywheel. "You see" he said, effusively, to the gentleman, "that it does not check it in the least; just try it yourself," handing him the waste. The gentleman advanced timidly and gingerly touched the flywheel, much as if he was polishing a watch case, and said, after reflection: "Enormous power!"

"I am an engineer of long experience" said the promoter, "and wish to inform you of certain facts in the case which you cannot be aware of, but upon which much depends. The 10 pounds on the gauge gives us hundreds of pounds in the cylinder, the increase being obtained through this system of levers which you see here. These multiply the original pressure many times, but we have only to pay for the 10 pounds of steam shown on the gauge. The levers also cause the main shaft to travel at twice the speed of revolutions (?) of the piston, so that we actually get twice as much power from the engine as others do. Now I will show you another test of the available power which any one can see for himself, without being an engineer." The promoter shut the globe-valve and the engine kept on spinning away for quite a while before it slacked up, then he turned triumphantly to the possible investor, who was greatly impressed. The promoter, however, carefully omitted to explain that the engine was not doing any work, and that it had an enormously heavy flywheel, so that it could not stop immediately if it had wanted to. What effect this jockeying had upon the investigator is unknown to me, but he disappeared into an inner office, the promoter following with alacrity.

Another curious feature of the freak-engine mania, with investors, is that they become ardent advocates of the scheme and serve to induce others of like ignorance to participate in the riches which are to to be made from it. They enjoin the greatest secrecy as to the existence of the engine, and seldom seek advice from persons who would be able to enlighten them. I have been approached by parties of the kind mentioned, but when I endeavored to learn something about the construction and plans of the engine and its inventor, so that I could form an opinion of its practicability, they refused to give any particulars, which, of course, ended the interview.

It has been stated in previous lines that the power developed by the freak engine is less than that of a standard reciprocating of the usual type, and this is readily seen when it is compared, engine for engine—that is, when equal piston areas and steam pressures are employed. For the sake of compactness, and from exigencies of the design, most of the freaks have very short piston strokes, say three or four inches, and by reason of this feature make a large number of piston strokes per minute; but even then the piston speed in feet per minute is very low. In the case of standard engines of small size, say 3 by 5 inches cylinder and piston stroke, running at 250 revolutions per minute, the piston speeds are, respectively, 125 feet per minute and 208 feet per minute, so that the freak must run nearly twice the speed of the standard engine for the same power nominal. It is claimed, however, by the advocates of such engines that this is a virtue instead of a defect, because they have some mechanism by which they gain power, usually levers, but sometimes cams, or their equivalent, and oftener than otherwise flywheels. If objection is made to this statement, the inventor wishes to argue the proposition infinitely, but life is too short for this; when men are willing to be deceived and deluded it is a thankless task to try to convince them that machines give out less than is put into them, instead of more: for only the testimony of their bank accounts can convince them.

> "Dangerous conceits are, in their natures, poisons, which at the first are scarce found to distaste, but, with a little act upon the blood, burn like the mines of sulphur."

This well describes the freak-engine person; not even his depleted exchequer restrains his efforts to get something for nothing, unless, indeed, he is willing to learn by adversity. The number of these last is exceedingly small. It is the commonest thing to find, in looking over a new freak engine, that it varies but slightly from similar experiments made by Richard Roe half a century or more ago, and it would seem that so far from having any ideas of their own, inventors had ransacked ancient engineering records in endeavors to find something to improve upon by a trifling change of detail or port. They loom up very large upon the port question, and devise such intricate contraptions in this direction that it occurs to a cynical person that it would require steam of more than ordinary intelligence to find its way through them.

Invention is easy. A mechanic who knows what he needs can readily devise machines for any useful purpose, let it be what it may: but discovery—ah! that is another proposition entirely, and when men think they have made one in mechanics, or science either, for that matter, they should go into retreat for a considerable period, and chasten themselves. They need restraint. It is always the dream of mechanical enthusiasts that they may one day make a discovery, and it is doubtless this will-o'-the-wisp dancing before them which leads the freak-engine man to prosecute his endless quest. Sometimes, indeed, he has a measurable success. His engine actually works; it causes the flywheel to turn regularly, and to those who see only outward and visible manifestations it seems to be a step forward: but the supreme arbiter in all cases is the coal pile and the dynamometer; when the verdict of these two is rendered adversely there can be no appeal. The common fate of all the pretty motions and elaborate systems of ports is the scrap-heap.

> "To what base uses we may return, Horatio!. . . . Imperious Cæsar, dead and turn'd to clay, might stop a hole to keep the wind away."

Similarly, the cupola may render the *disjecta membra* of the once wonderful freak engine into vulgar pots and kettles for scullions to wreak their rage upon.

# FOUNDRY MANAGEMENT IN THE NEW CENTURY.

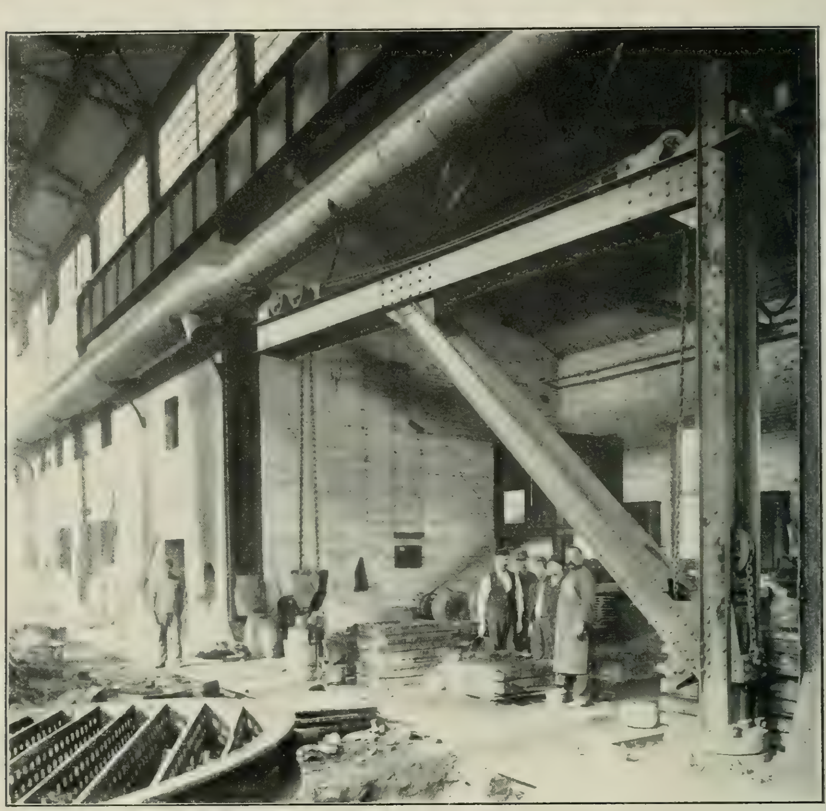
*By Robert Buchanan.*

## II.—CRANE SERVICE FOR THE FOUNDRY FLOOR.

Mr. Buchanan's series began in our preceding number with an article on "The Economical Production of Castings," concerned chiefly with the general arrangement of the foundry, the question of heating and ventilation, and the supply of tools and minor plant. The present section takes up the crane service and the drying of cores and moulds. The next paper will deal with "Moulding by Hand and by Machine."—THE EDITORS.

Of all foundry appliances, the cupola alone excepted, cranes rank highest in importance. An ample crane service, as well as speed and nicety of movement, have an incalculable effect in producing the proper spirit and tone in which the work should be carried on. In short, if the cranes are slow, the pace will surely be slow; if fast, then the work can be and ought to be smartly produced. With bad or indifferent cranes and deficient crane service, bad results are certain.

I have already indicated that jib cranes occupying the middle of the foundry floor, whatever their services in the past may have been, are an anomaly and a hindrance in these times. There is one position in which a jib crane excels all others, and one only, and it does not come within the scope of these articles. Nothing can excel a jib crane placed at the raised centre of a circular pit in which pipes are cast on end; but in any other foundry and in any other circumstances jib-cranes are best relegated to a position away from the centre of the foundry floor and to a secondary position as auxiliaries to travelling cranes. In proof of this contention I need only mention the restricted sphere of action of the jib crane, the awkwardness and loss of time with which any ladles, moulding boxes, large cores, etc., are transferred from crane to crane, and the general dislocation of moulding operations which ensues when this is being done. As an auxiliary, the jib crane is in its proper sphere, and that a useful one. An arrangement of jib cranes which in practice has been found most serviceable, is one in which a crane is placed at each pillar, each crane having a radius greater than half the distance between it and the



HYDRAULIC JIB CRANE, WITH HAND TROLLEY TRAVERSE GEAR.

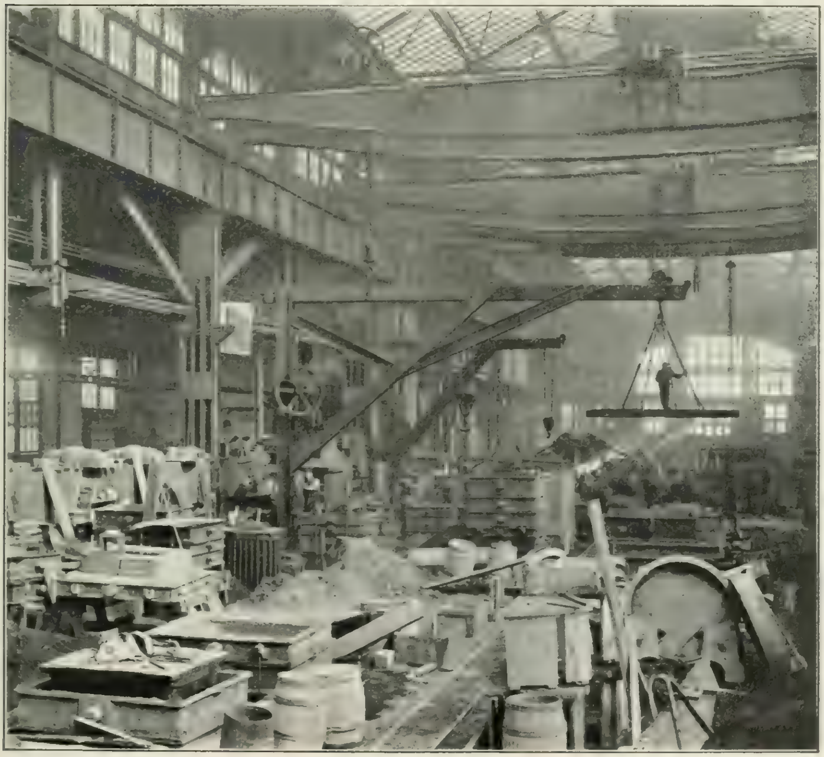
Jib is rigidly supported at fixed height and motion of the ram conveyed to the load by chains. Working pressures, 300 to 750 lbs. to sq. in. R. D. Wood & Co., Philadelphia.

next crane. In each pair of cranes one is higher than the other, so that when swung in line with the girders the point of one jib is under the other and both are out of the way of the travelling crane. Such an arrangement gives a good sweep of the floors and allows of the transfer of ladles, moulding boxes, etc., should the travelling cranes be so engaged as to render inconvenient their use for that purpose at the moment. However, the main function of these jib cranes is that of giving the numerous minor but important services which moulders so often require, leaving the heavy lifting and transport in general along the foundry, to the travelling cranes.

There should be a crane sweeping the space immediately in front of the drying stoves, for the purpose of loading onto the stove carriages the smaller class of loam and dry-sand moulds made there. This crane performs the necessary lifts for closing the moulds.

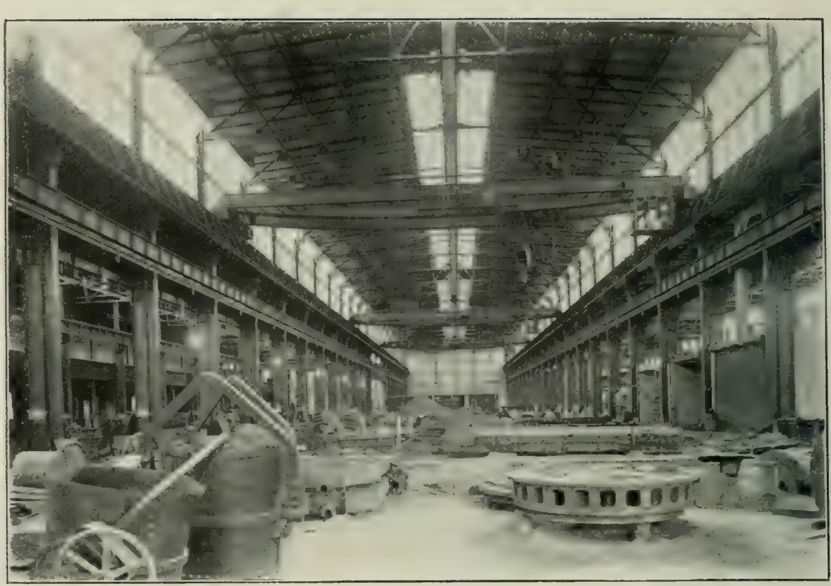
A jib crane or cranes should be at the service of each pit, whether making dry-sand or loam work. This gives the moulders engaged in heavy core work the unhampered and sole use of a crane for all purposes except the heaviest lifts. Thus the work can proceed unchecked by stoppages caused by lending the crane to others requiring its use, as often happens if a long bay be served only by a traveller.

The kind of jib crane most suitable as an auxiliary will depend on the outfit in other directions. If there are dynamos for lighting and power purposes, then electric jib cranes will be the best. A few such cranes may be readily shifted from point to point as the work requires, connections being available at these positions. The facility with which such connections may be made gives the electric crane a certain advantage over the hydraulic crane, but neither type would pay unless as a user of power developed for other purposes as well. For foundries of medium size having neither electric nor hydraulic

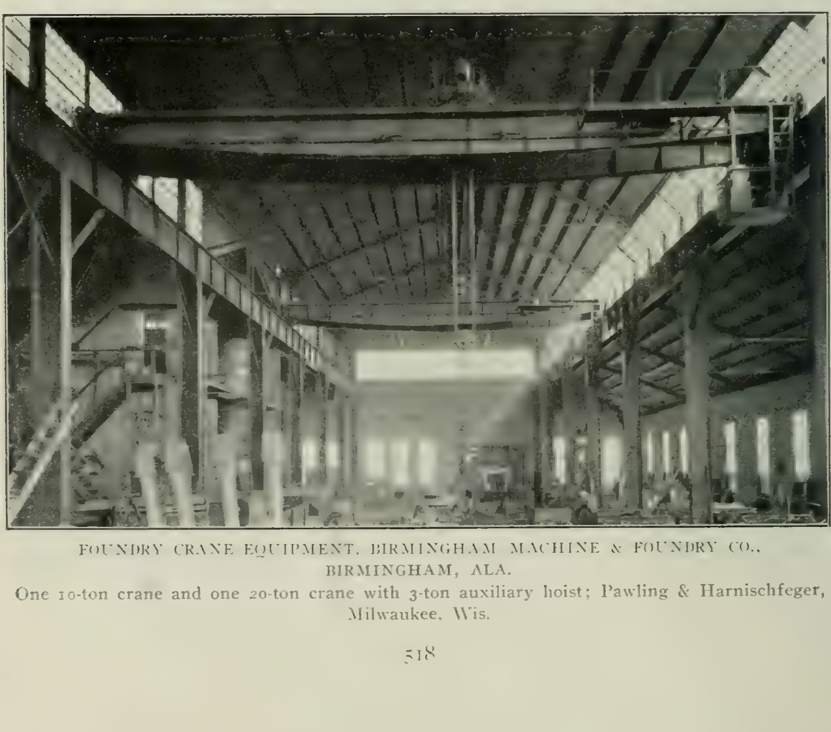


PORTABLE ELECTRIC POST-CRANE BEING TRANSPORTED FROM ONE POST TO ANOTHER BY OVERHEAD CRANE.

Foundry of the General Electric Company, Schenectady, N. Y.

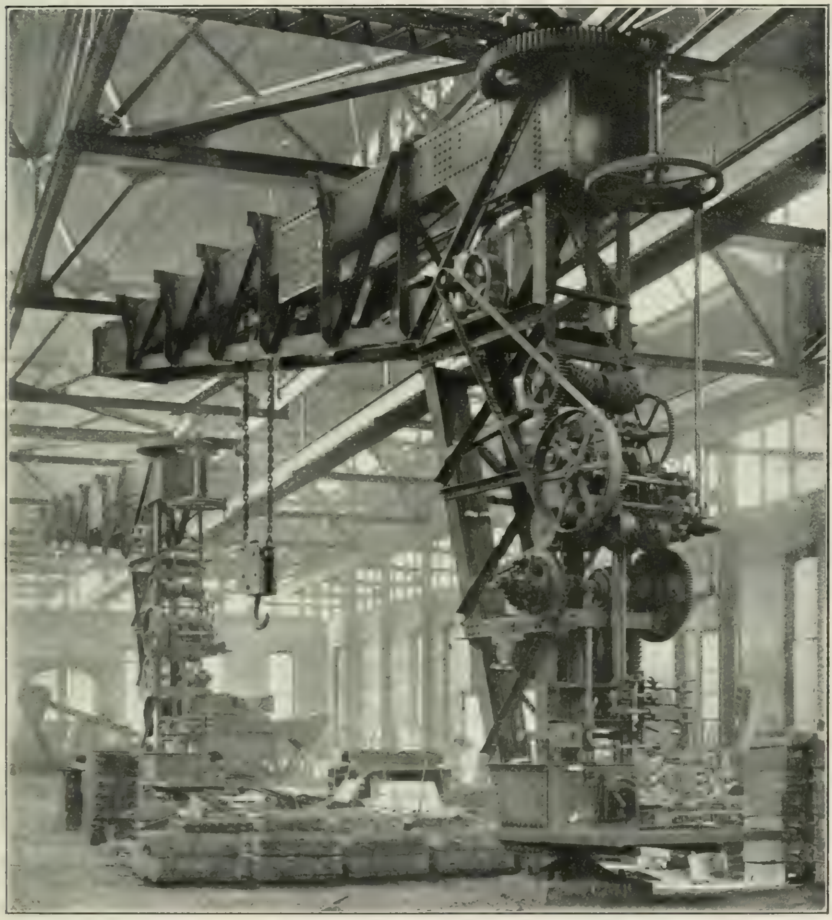


CRANES IN THE FOUNDRY OF THE ALLIS-CHALMERS CO., WEST ALLIS, MICH.
In the foreground is a 60-ton Shaw electric crane with 15-ton auxiliary hoist and a span of 78 feet. The first three-motor crane built in the United States was designed by Mr. A. J. Shaw for the Milwaukee foundry of the Allis company in 1889, and was in continuous use for ten years.



FOUNDRY CRANE EQUIPMENT, BIRMINGHAM MACHINE & FOUNDRY CO., BIRMINGHAM, ALA.
One 10-ton crane and one 20-ton crane with 3-ton auxiliary hoist; Pawling & Harnischfeger, Milwaukee, Wis.

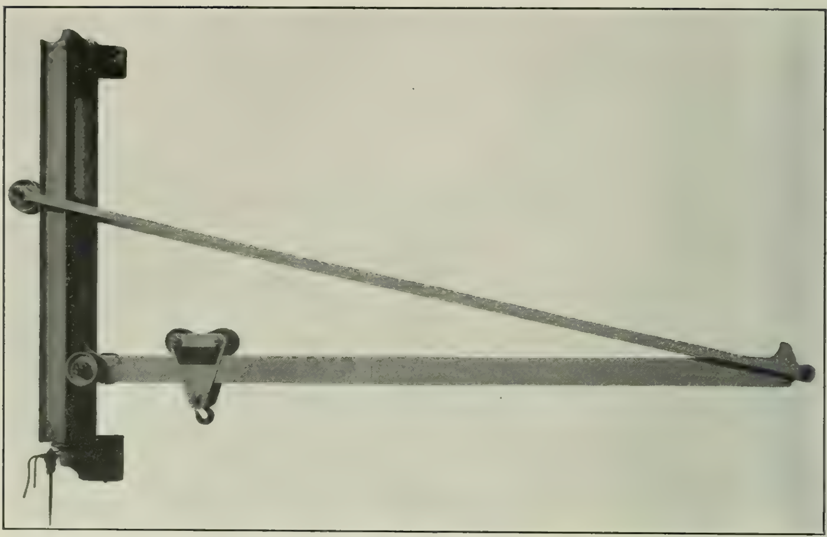
power, the jib crane with hand winch is much to be preferred to the smithy crane with overhead chain block one sometimes sees in a foundry. The smithy crane may be serviceable in a smithy; in a foundry it is only better than none, and that is the best which can be said for it.



10-TON ELECTRIC JIB-CRANE IN THE FOUNDRY OF THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

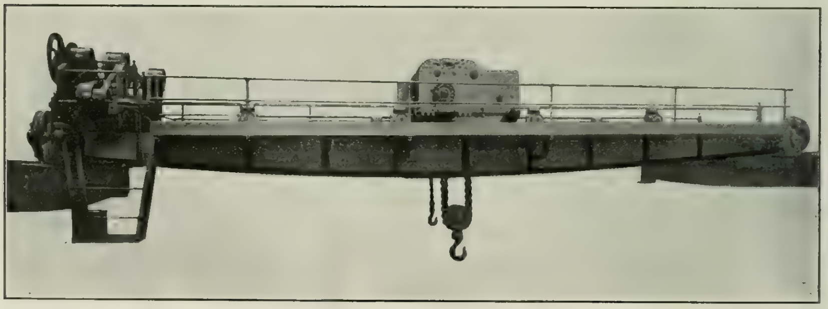
Effective radius of jib, 30 feet; has two hoisting speeds and lowers by power or brake as desired; constant-speed motor. Wm. Sellers & Co., Philadelphia, Pa.

Coming now to travelling cranes; the type most in use in Britain is that driven by a rope carried on pulleys, the power being transmitted to the winch or crab by means of a square shaft. A good deal of power is absorbed by the various pulleys carrying the rope, but I

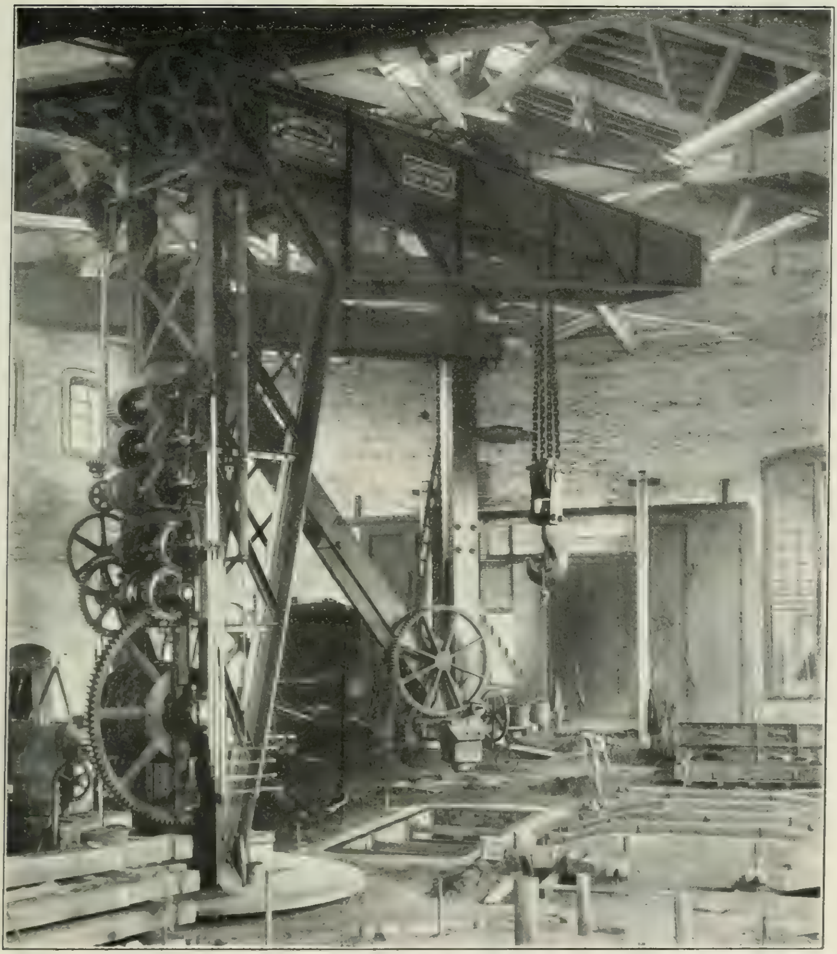


HYDRAULIC BRACKET CRANE. R. D. WOOD & CO., PHILADELPHIA.

take leave to doubt that it takes 5 to 6 horse power for every 100 feet of rope, as has been stated. If that were so, some of us would be in the evil case of having no power left over to do the work. When well made, the rope-driven crane is a very serviceable tool. Its principal weaknesses are these: Danger of the driving rope breaking, danger of the short belts on the crane breaking (one being a cross-belt), and danger of the slipping of the belt on the main drive should the lifts be very heavy. I have found it a good plan to have a spare rope ready spliced hanging along the girders, and this can be put into position and running resumed in a comparatively short time. To get the spliced rope on to the tightening pulley there is, of course, a



30-TON ROPE-DRIVEN OVERHEAD TRAVELLING CRANE FOR THE FOUNDRY.
Craven Bros., Ltd., Manchester.

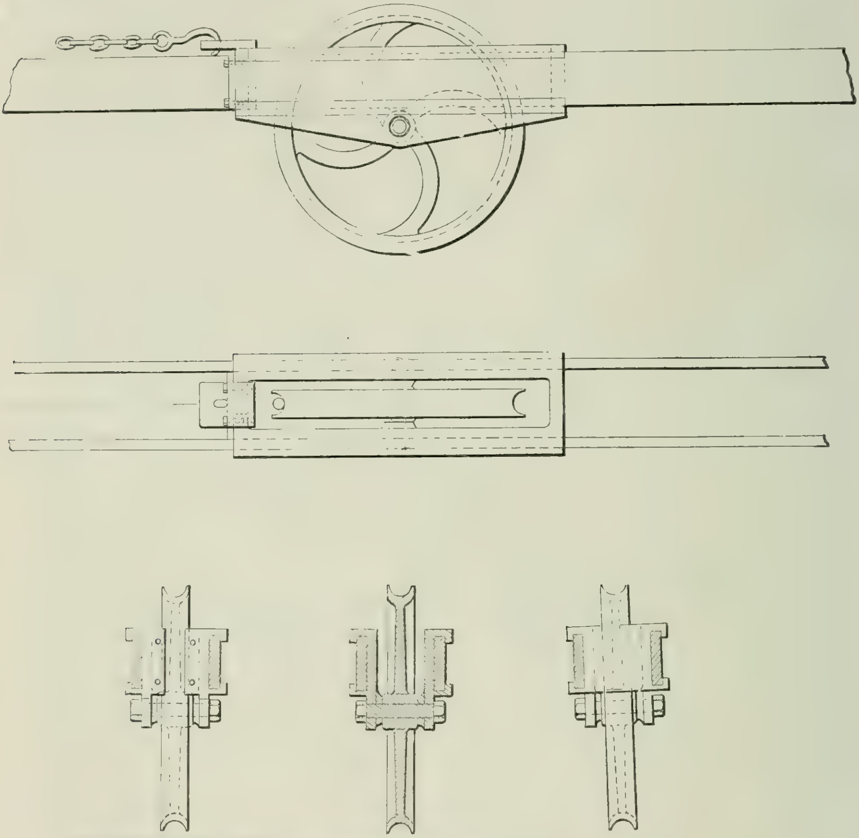


30-TON STEAM JIB CRANE, FOUNDRY OF J. M. POOLE & CO., WILMINGTON, DEL.

Height of post, 26 ft.; effective radius of hook, 23 ft. All movements by power. Driven by 8 by 8 engine, receiving steam through upper pintle and discharging through foundation plate. Wm. Sellers & Co., Philadelphia.

suitable opening in the carriage way with covering plate as shewn in the diagram on the next page.

Having a spare rope ready to take the work as stated allows one to stop the use of the rope at work so soon as it shews signs of giving way, and so an actual breakage seldom takes place. If the rope does break it is usually when there is a large ladle of iron suspended from the crane, or some similarly awkward circumstance. It takes some thinking as to whether it is best to pour the metal into small ladles and so cast what you can, and pour the remainder on the floor by means of the small ladles, or risk getting the rope running again before the metal sets in the large ladle. It is almost always wise to pour the metal out, and not run the risk of having a large block of solid iron of no use to anybody.



C[illegible] showing plates removed and slot for inserting rope

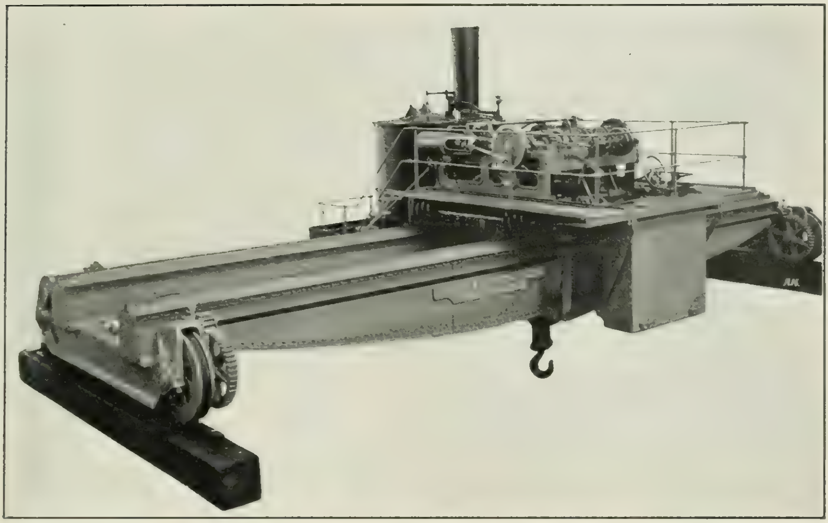
Section through center

Closed end

SELF-ADJUSTING CRANE-ROPE TAKE-UP.

Scale approximately 1/10 full size.

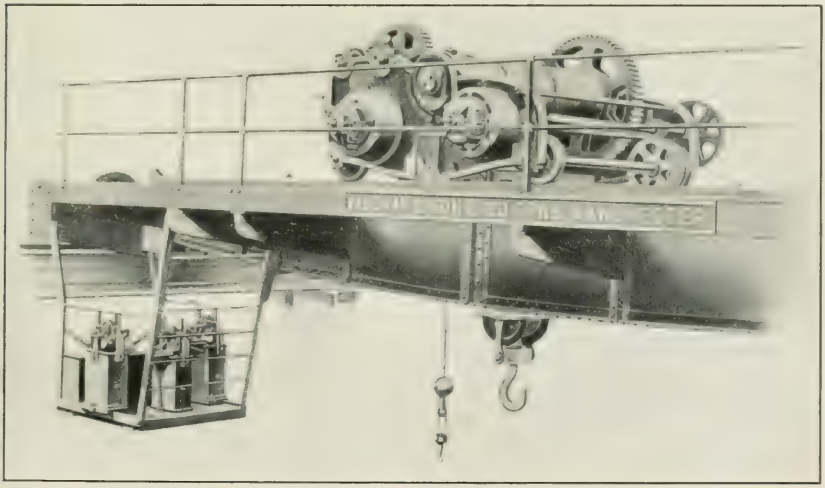
It should be seen that the wearing surfaces on foundry cranes are amply large, as otherwise the bearings soon wear down in the dusty atmosphere. Worms and worm wheels wear thin at point of contact, and if the square shaft gets out of line a serious vibration, especially with light loads, is set up. I have seen green-sand moulds shaken out by such vibration; the preventives are ample bearings and wearing surfaces, shafts in line, and the fullest possible exclusion of dust.



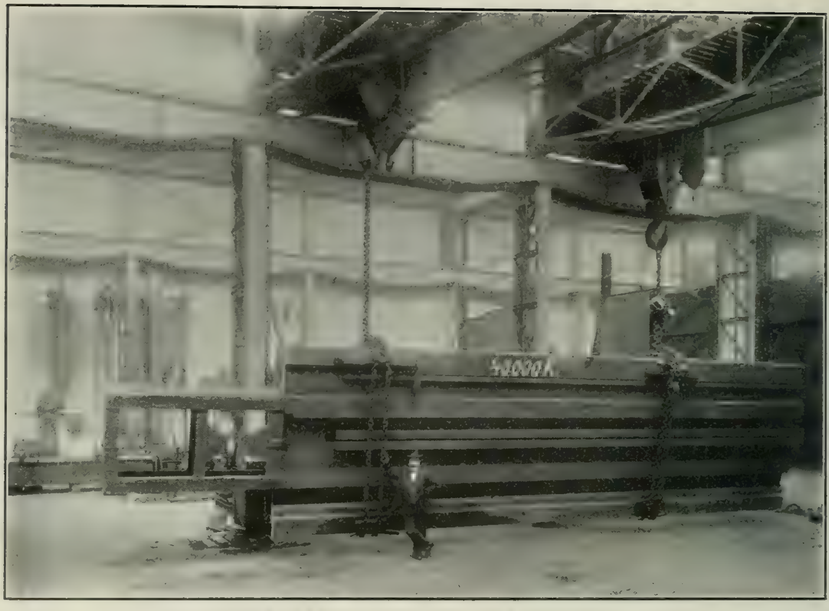
STEAM FOUNDRY CRANE FOR THE GREAT NORTHERN RAILWAY WORKS, DONCASTER.
By Joseph Booth & Bros., Ltd., Leeds, England.

One advantage of the rope-driven crane is, that it can be attended by a lad of 15 or 16 years. This considerably reduces the cost of attention, as in the case of belts breaking or anything else going wrong the engineman or general repairer sees to that.

Another useful type of travelling crane for foundry use is that which is steam-driven, as in the example shown on this page. This

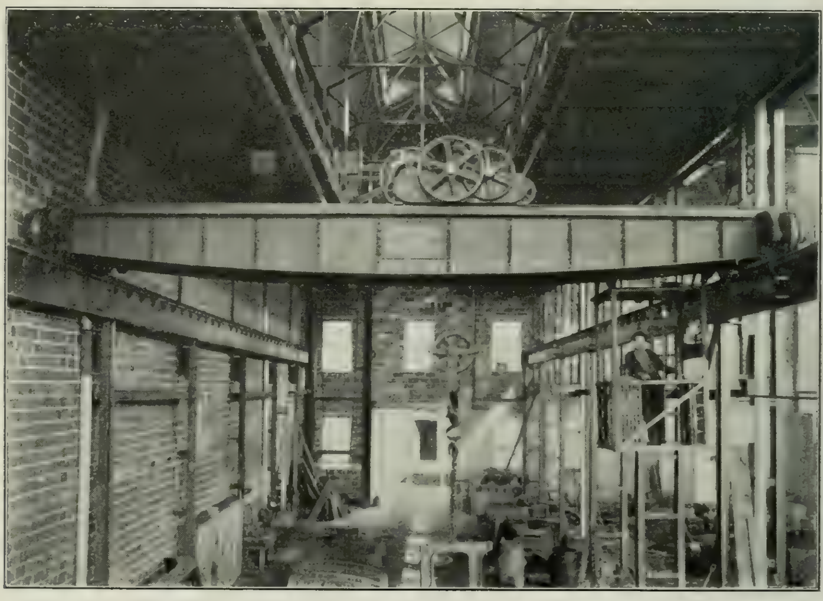


20-TON FOUR-MOTOR ELECTRIC TRAVELLING FOUNDRY CRANE.
Vaughan & Sons, Ltd., Manchester.



HEAVY CRANE SERVICE FOR THE FOUNDRY.

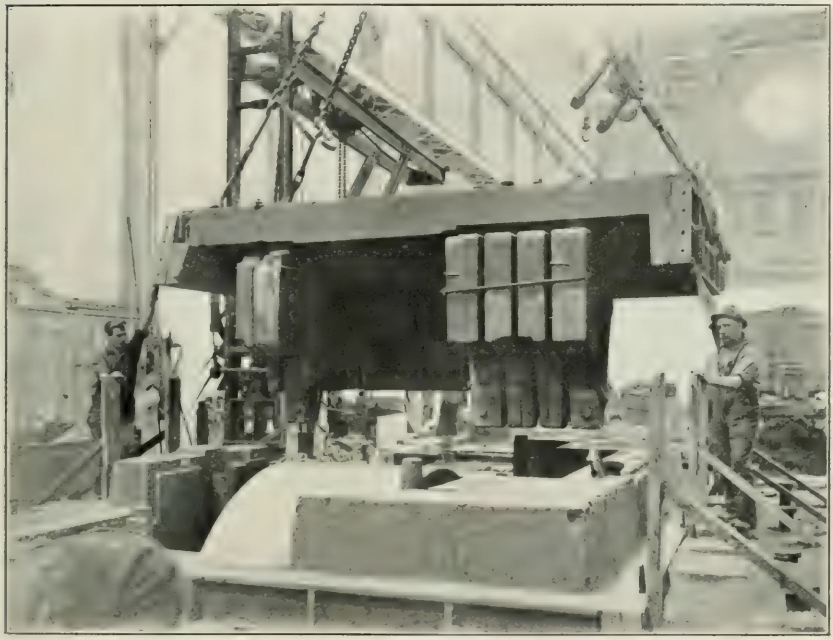
A large lathe bed in cleaning room, Deutsche Niles Werkzeugmaschinen Fabrik, Berlin.



THREE-MOTOR ELECTRIC CRANE OVER FOUNDRY CLEANING FLOOR.

Installed by Northern Engineering Works of Detroit in foundry of Braddock Mfg. and Foundry Co., Braddock, Pa. Illustrating modern practice in facilitating handling of castings in the cleaning room.

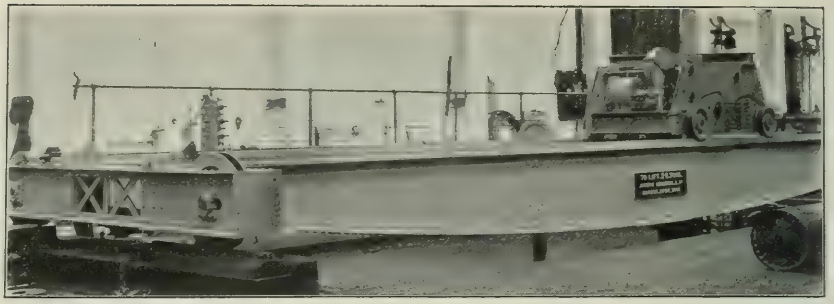
crane has excellent speed of travel, and a clever craneman will travel, hoist, and traverse simultaneously if required with the greatest facility. In this respect I should say it is difficult to surpass. It requires, however, a higher measure of personal skill in the craneman than is required in a rope-driven crane. In parting moulds, drawing patterns, or any similar operation involving nicety of movement, boiler pressure, quantity of steam admitted to the cylinders, and weight of load to be lifted all share in producing the lifting speed. In the cases



MOULDING AN ENGINE-BEDPLATE COPE WITH CORES HANGING, FOUNDRY OF THE WESTINGHOUSE MACHINE CO., EAST PITTSBURG, PA.

Suggestive of the nicety of crane movement necessary in foundry service.

mentioned the speed is desired to be, at the beginning at least, more felt than seen. If a craneman wants to get into trouble he has only to lift pattern or top part rapidly for the first inch and he at once attains his desire. Intelligence and experience, however, can get very satisfactory results with this crane, but the attendance has necessarily to be fairly well paid. As this crane is self-contained and independent of connection with any other motive power or gearing the liability of stoppage, temporary or otherwise, is very little. One drawback it has is the necessity of getting water and fuel, usually



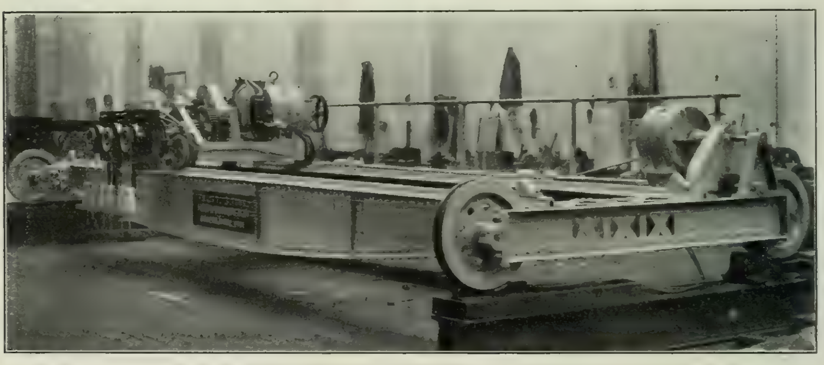
20-TON ELECTRIC FOUNDRY CRANE.

Enclosed first-motion gearing. Controlled from a cage travelling with the crane in the usual manner. Joseph Adamson & Co., Hyde, England.

gas coke, up to the boiler. This is done by having a supply of both fuel and water on the cupola platform or other suitable elevation. One other important thing has to be borne in mind, and that is the liability to fire by using a boiler near the roof. If the roof is constructed of iron with slate and glass as the covering materials, well and good; but wood is dangerous.

The use of electric cranes has extended greatly in the last five years, but British foundries at least, in marked distinction to American practice, have been slow to adopt them. Fear of the fine dust which floats about in the upper air of the foundry predisposes many to adhere to the rope-driven or steam traveller. With well fitting shields and covers the risk of trouble arising from the cause mentioned may be reduced to a very small point indeed.

The electric traveller is almost certain, in the not very far off



ELECTRIC CRANE TO LIFT 3 TONS.

Fitted with auxiliary hand-gear, and arranged to be controlled from the floor, if desired, thus saving the cost of a special attendant. Joseph Adamson & Co., Hyde, England.

future, to supplant in great part all other types of travellers for use in large foundries. The craneman has perfect control of the hoisting and lowering speeds, and that, whatever the crane may be, is the greatest necessity of all. Travel may be had of any desired speed, and when not in use no power is being expended. This latter feature is a distinct advantage over the rope-driven crane, and in cleanliness and non-liability to cause fire the electric is superior to the steam traveller.

Deficient or inefficient crane service is a fruitful cause of loss of valuable time. I have known a dozen or more moulders to sit about for two hours or even a longer time waiting on crane service, and this is by no means an isolated case. It is useless to look for good results where such a state of matters obtains. The crane service is deficient if the moulder has to wait on the crane five minutes. It is inefficient if the moulder is caused extra work because of bad lifts or breakdowns in coreing or closing moulds. No effort or expense should be spared to make waiting on cranes unknown, and to reduce to a minimum the additional work given the moulder by reason of bad lifts, etc.

30-TON THREE-MOTOR ELECTRICALLY DRIVEN OVERHEAD TRAVELLING CRANE.

Craven Bros., Ltd., Vauxhall Works, Manchester, England.

Stoves for Drying Cores.—For drying small cores all are familiar with the rectangular erection having a cast-iron plate on top (this plate usually being cracked) and a fireplace and fire under the plate on which the cores are placed to be dried. A great improvement on this is the core oven of the "Millett" type. It is more economical of fuel and dries the cores without burning them. Where gas is avail-

25-TON THREE-MOTOR TRAVELLING CRANE IN THE NEW FOUNDRY OF CRAVEN BROS., LTD., REDDISH, ENGLAND.

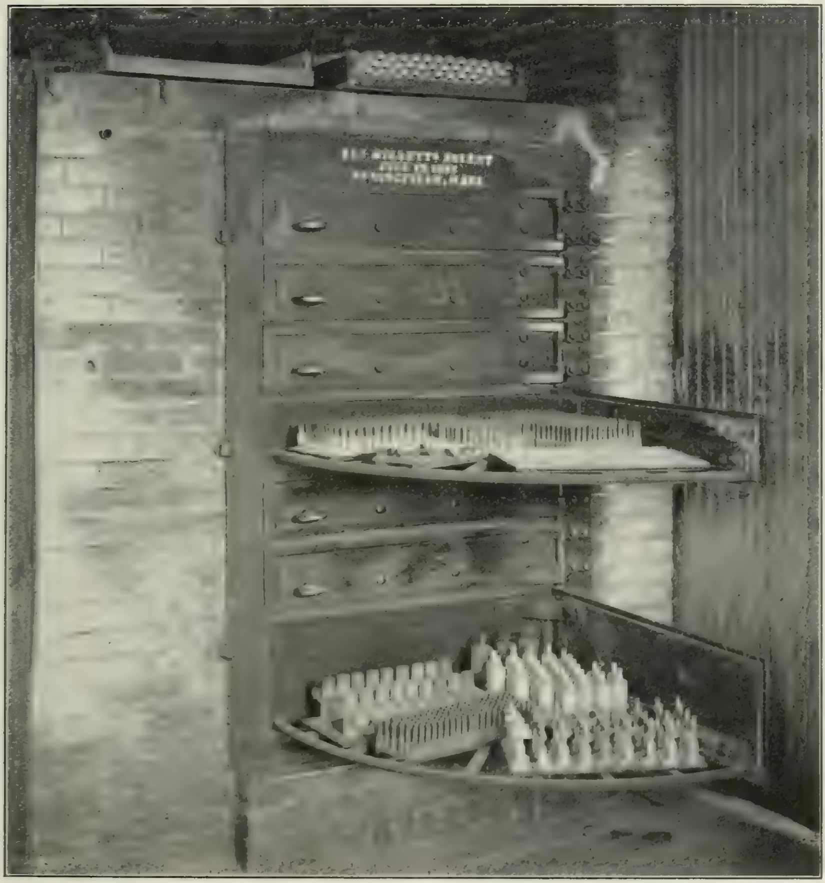
END OF BAY CONTAINING MOULDING MACHINES, FOUNDRY OF THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

Showing chain-hoist and overhead trolley.

able as the heating agent this type of stove is difficult to excel for drying small cores.

The illustration shews the principal features of this stove.

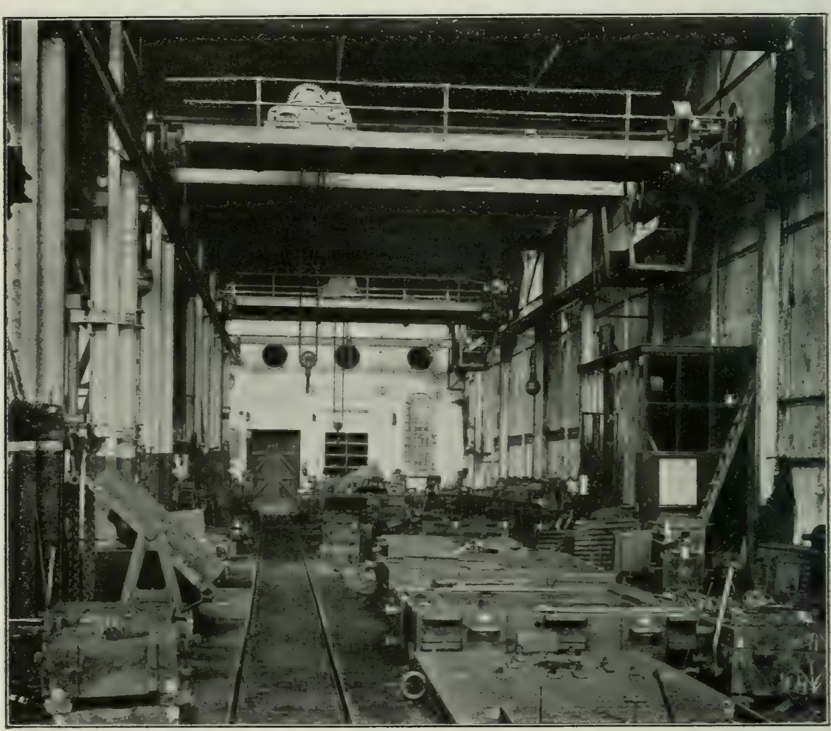
Stoves for Drying Moulds.—Any change which has taken place in the last twenty-five years in stoves for drying moulds and large cores, has been in details only and not in the main features. These stoves are usually of a rectangular form and of a size suited to the moulds to be dried. They are fired from one end and the smoke from the fire and steam from the moulds are drawn from the stove by a flue placed near the floor at a point furthest from the fire. The flue is connected to a chimney, and in either flue or chimney there should



MILLETT CORE OVEN, FOUNDRY OF THE STEBBINS MFG. CO., BRIGHTWOOD, MASS.

Shewing the manner of opening the swinging trays.

be a damper by which the draught may be regulated from the outside. The fire may thus be retarded, or if the fire is burnt down the heat may be retained, at will. Where stoves have to be entered while the fire is still burning, as is necessary in making loam cores, they should have in addition a top chimney going up through the foundry roof to the open air. Such a chimney need be of only moderate area, say 144 square inches, and should be closed by means of a damper which is opened only when entrance to the stove is about to be made. By this means the hideous wreaths of smoke which one sees so often when stove doors are opened are dissipated directly into the atmosphere, and not into the foundry first.



ELECTRIC CRANE INSTALLATION IN FOUNDRY OF MESS. W. H. ALLEN & CO., LTD., BEDFORD, ENGLAND.

When moulds are heavy the carriage on which they are placed is made to run on rails, these rails having a slight inclination, or slope into the stove. This slope of rail need not exceed one inch in twenty feet and assists the getting of the carriage into the stove where the "pinch bar" applied to the wheels of the carriage is the means used.

If the pinch bar is the means by which the carriage with the moulds on it is got out of the stove, then the rails ought to be level. The slope into the stove is only of advantage if the carriage is drawn out by means of the crane or other application of power which can overcome the adverse grade without the expenditure of manual labour.

Where the smaller class of loam or dry-sand work is common, it is best to have no rails whatever and instead have the floor outside the stove and the floor of the stove itself plated with 1-inch plates which have been cast in open sand. A number of small carriages as shewn on page 532 serve as stands on which the loam moulds may be built, run into the stove, dried, finished, and cast, in many cases without having to use a crane unless it be to close on the "cope" or top mould. Dry-sand moulds, of course, may be loaded on these and run into the stove, but whether it be loam or dry-sand moulds which are being made, if much coreing has to be done it is best to get the mould on to

ELECTRIC CRANES IN THE CHILLED-ROLL FOUNDRY OF THE UNITED ENGINEERING AND FOUNDRY CO., VANDERGRIFT, PA.

In the foreground is a 20-ton crane with 3½-ton auxiliary hoist; the other two are 3[illegible] ton cranes with 5-ton auxiliaries; the span is 60 feet. Shaw Electric Crane Co., Muskegon, Mich.

the floor. The moulder is thus not troubled by the heat of the carriage and his work is at or under his level, not above it.

The means by which heavy moulds are got into and out of the drying stoves are few in number, and the most primitive of all is the most in use. I refer to the use of the pinch bar previously mentioned, which, as most people know, is applied to the wheels of the carriage; by means of a "heel" formed upon the pinch-bar a strong leverage is got. With a hot stove and hot carriage and moulds, getting out the carriage by the means mentioned is a work of the most trying nature. If a travelling crane is available, or a jib crane be in suitable position, then the carriage may be got out easily. In such a case it is well to have a sheave or pulley block fixed on the floor at a point beyond the rails at the end furthest from the stove. This obviates all risk of the crane tipping up a badly balanced carriage. A similar pulley block at the inner end of the stove may also serve to pull in the carriage by means of a wire rope led through the two blocks, if one end be attached to the crane mentioned and the other to the inner end of the carriage carrying the moulds.

An excellent method for getting stove carriages into and out of the stove is shewn in illustration of stove carriage in use by the Falkirk Iron Coy. One of the wheel axles is extended in length at one end. On this end is keyed a ring having recesses as on a capstan. Two capstan bars are

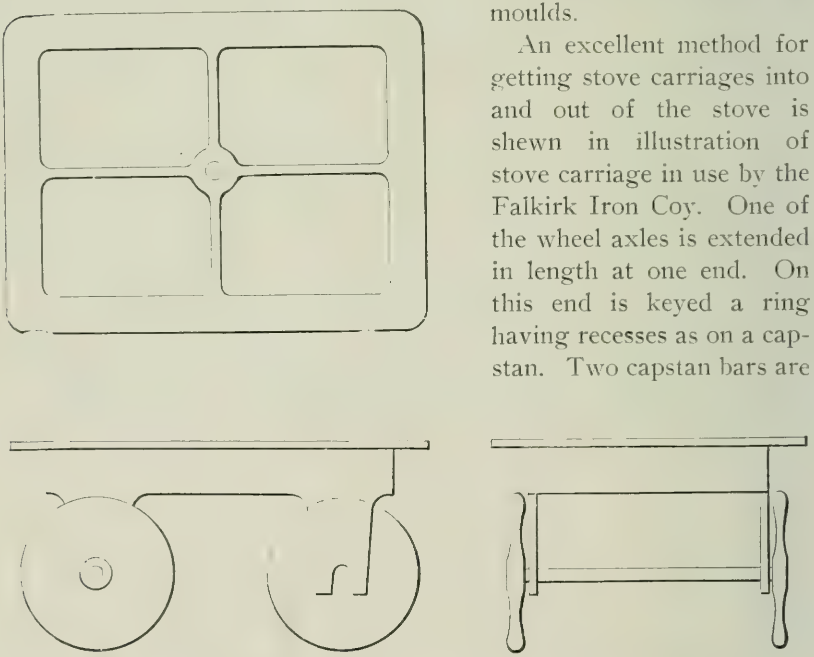
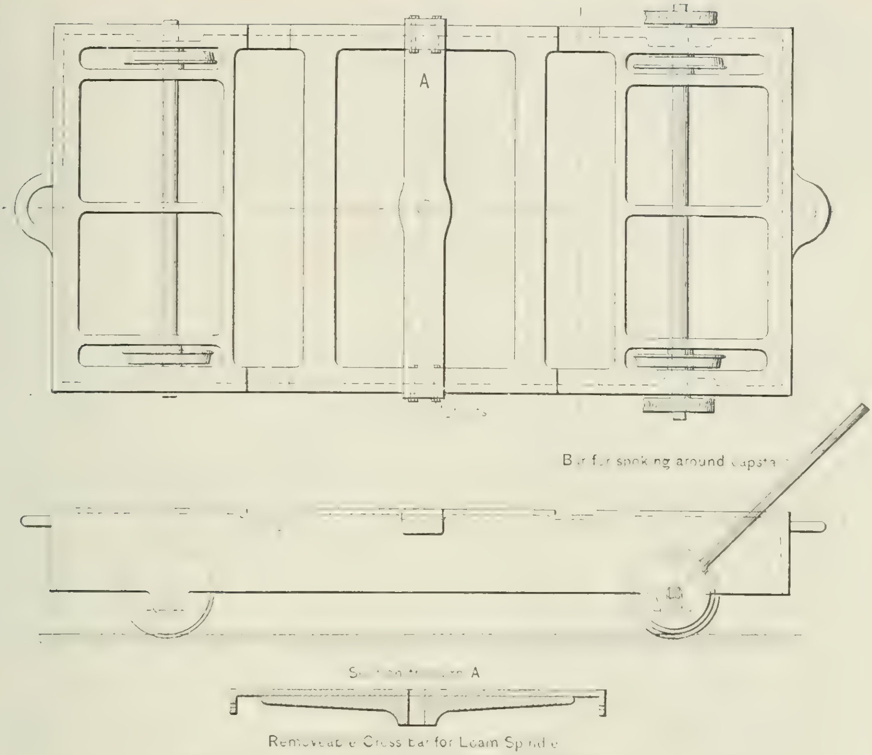


FIG. 6. STOVE CARRIAGE FOR SMALL LOAM AND DRY-SAND MOULDS.

3 feet by 4 feet, 2 feet high; thickness of metal about 1 inch; axle, 1 3/8 inch.


A
Bar for spoking around capstan
Section through A
Removeable Cross bar for Loam Spindle

CORE-STOVE CARRIAGE.
Scale approximately 1/32 full size.

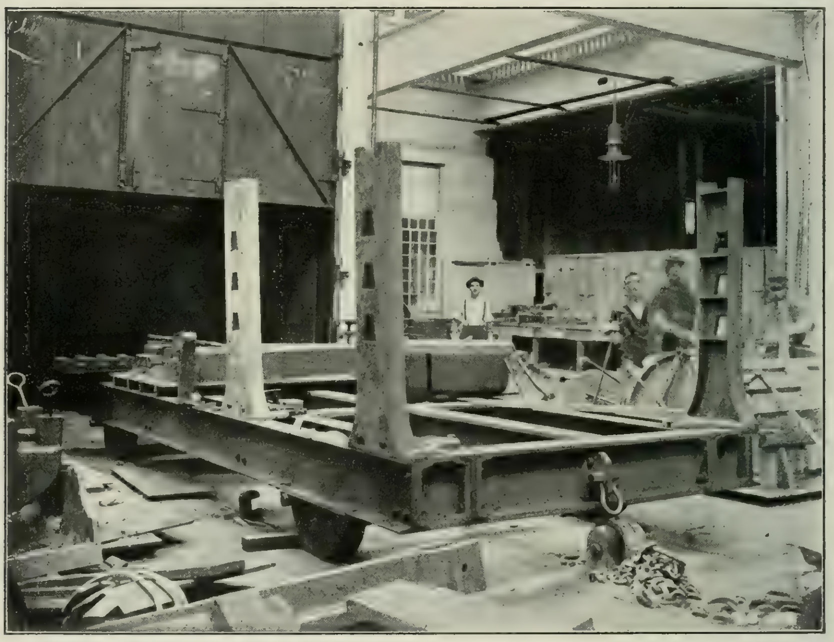
used, and by its means two men can move fairly quickly a carriage carrying 8 or 10 tons of moulds.

Capstans placed on the foundry floor and also cylinders using compressed air are occasionally used, and situated within the stove itself, but these are exceptions of a very rare character and are of the most limited application.

Stove doors are usually made to lift vertically and are made to do so easily by means of balance weights hung on the ends of chains passing over pulleys. This arrangement is quite satisfactory for most requirements, but I have seen an arrangement by which two stove doors of very large size are handled hydraulically.

Heating the Stoves.—For heating the stove the means most commonly used are rectangular fireplaces burning coal or gas coke. Sometimes the latter fuel is burned in "baskets" or "choffers" placed on the floor of the stove. This latter is a very indifferent and expensive method of drying the moulds. Coal is better than gas coke for rapid working, but has the disadvantage of smoking the cores and moulds. The calorific value of coal is largely in excess of that of a similar quantity of gas coke and the coal requires a larger grate area for burning to best advantage. The fireplace for either coal or gas coke should be as near the floor as possible, and, where the exigencies of space will allow, ought to be wholly inside the stove, and be fired from the outside. Thus no heat is lost by radiation, unless it be through the walls and door of the stove.

Producer gas is sometimes used to dry the cores and moulds, but unless it be under certain favourable conditions its use is not economical nor even altogether safe. Because gaseous fuel is a most excellent thing in a Siemens' furnace, it does not follow that it is the best fuel for a drying stove. It is certainly more cleanly than coal or other solid fuel, but it has distinct disadvantages. The foundry which possesses gas-fired stoves must have other uses for the gas made in the producers if gas is to compare favourably in cost with solid fuel. The stoves are used intermittently, but gas producers work most favourably when in constant operation. Besides, the gas from several gas producers will certainly be more regular in quality than the gas from one. One gas producer will make gas for several stoves, but should



CORE-OVEN TRUCK, WESTINGHOUSE MACHINE CO., EAST PITTSBURG, PA.

bad gas be made, that is, too great a proportion of carbonic acid, the gas in the stove will cease to burn and the carbonic acid and carbonic oxide—the latter a very poisonous gas—will fill the stove and spread along the foundry floors with rather alarming results to any who are there. The cost of gas producer, valves, piping, and attention will be more than that of any system of firing by solid fuel, unless, as already mentioned, the gas so used is obtained from a supply designed for a wide application of gaseous fuel. Under the latter conditions only may gas be profitably employed to dry moulds and cores.

Drying Moulds in the Floor.—When large dry-sand moulds have to be dried where they are made, being too large for any stove to take in, or by reason of the mode of moulding adopted leaving that as the only course to follow, a good system of drying becomes a most important matter. The drying is done in most cases by forming trenches outside the mould, these trenches being filled with coal.* The whole is covered with sheet-iron plates when the coal has got well alight. No attempt is made to provide air for the proper burning of the coal, and so the foundry is constantly full of a most irritating smoke, provocative of headaches, watery eyes, and bad language. A foundry with three or more pits constantly fired by such means is a most excellent place to keep away from. Such an abomination was allowable when no other way was known, but now that a better, cleaner, and cheaper system is available, foundrymen ought to see to it that the smoke-laden atmosphere due to the firing of pits is gone, never to return.

Drying Moulds by Hot Air.—This system, introduced some years ago, was adopted by several progressive foundries and it is to be hoped will, in the near future, supersede in great part the use of coal for drying moulds in pits or on the floor. The illustrations which appear on the next page shew how the system is applied and render unnecessary any extended explanation. Flexible pipes connected to a blast main convey air to a portable furnace of which gas coke is the fuel. The portable furnace is placed over the dry-sand mould as shewn, with the result that a copious stream of hot air and the products of combustion completely fill the mould, with most satisfactory effects as regards drying and with an absence of smoke, ash, and dirt. If the mould be shallow the hot air may be "baffled" as shewn on page 536 and burning of the mould thus be avoided.

As only a fine dust is present in the mould, this is quickly brushed

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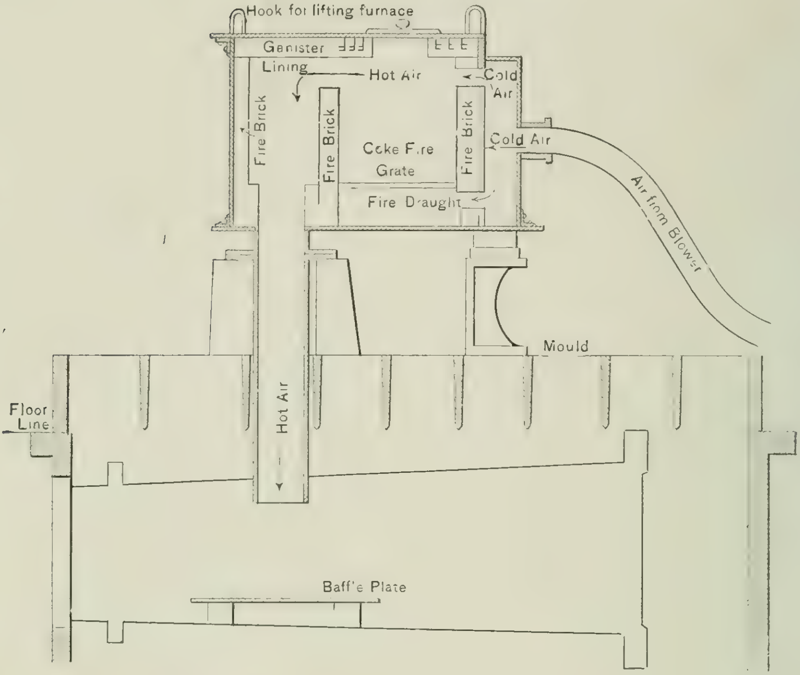
* Fire-lamps, that is iron baskets containing coal or gas-coke are also often hung inside the mould to assist the drying.



DRYING IN PITS WITH HOT AIR.

off and coreing is proceeded with in a very short space of time. Drying by hot air proceeds from the face of the mould downward and outward and is very equal in its effect on all parts of the mould. Drying by fires in trenches round the mould proceeds from the outside inwards and the bottom of the mould, which has often the weight of cores to carry and "scabs" the most readily, is least dried of all. A hot-air-dried mould dries from the face inwards for only a few inches and so requires smart handling in coreing, closing, and casting, so that the damp does not get to the face before getting the metal in. Every dry-sand and loam mould should be cast while still warm and so a good arrangement for handling cores and moulds is a necessity for the best and most profitable use of this very important advance in recent foundry practice. The way the mould is got ready for hot-air drying is as follows: The joint is sprinkled with parting sand and the top tried on. If there are no "crushes" the top is carried up on "sconces" or supports which cause the top part to rest one inch or so above the mould. The hot air is turned on and when the greater part of the steam has been expelled, the opening round the mould is closed by means of loam and the heat is kept in. Moulds to take 14 to 16 tons of metal are thus successfully dried.

Skin Drying of Green-Sand Moulds.—The skin drying of green-sand moulds is essentially the drying off of water which has been put on to the mould to fix the blacking on the face more effectively than simple "sleeking" with tools will do. Skin drying is used extensively in the United States and less commonly in Great Britain. It may be used in many cases as a good substitute for the smaller class of dry-sand moulds, as it gives a skin to the casting little inferior to that of dry-sand coated with blacking having claywash as the fixing medium. A green-sand mould which is subject to much pressure of metal may be helped to withstand such pressure without "swelling" by means of skin drying.

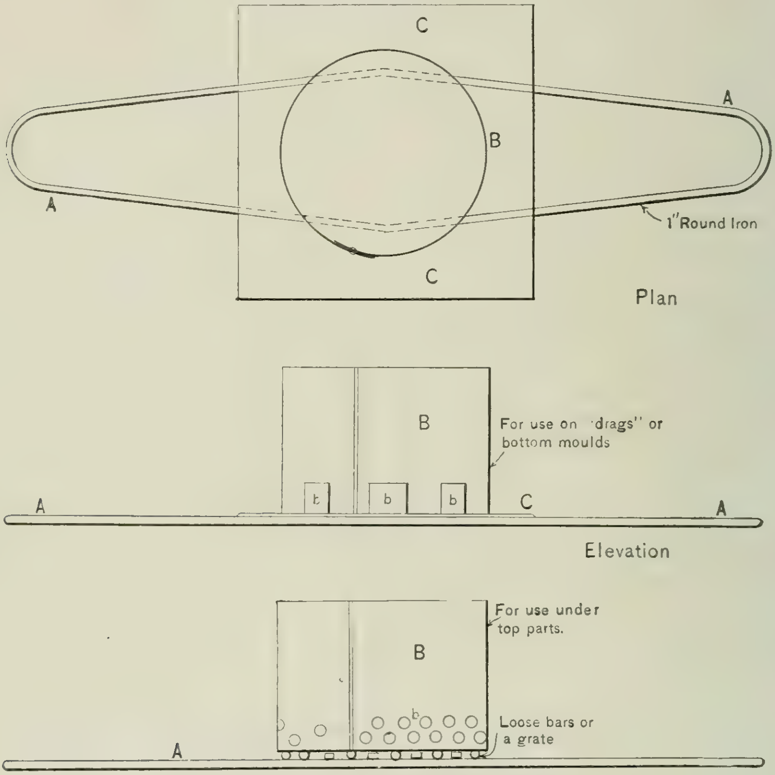
Green-sand moulds intended to be skin dried are made in the same way in every respect as for ordinary green-sand work, care being taken that the sand is not so damp as for dry-sand work. When the mould is finished, blacked with the bag and the blacking sleeked or smoothed with the tools, the surface is brushed over with water by means of a fine camel's-hair brush. A still better skin is obtained if some good plumbago or "black lead" be mixed in the water, or, as some recommend, boiled in the water. The mould must not be sleeked after the water is applied. In cases where the pattern leaves perfectly and sleeking of dry blacking would readily distort the lines, the flutings of a column for instance, then by means of a swab made of the finest quality of hemp, a mixture of charcoal blacking and plumbago in water may be applied with excellent results by one skilled in the use of the swab.

There are several means adopted to effect the skin drying. The crudest is that of casting a slab of metal and suspending it over the mould. Better than that, but with an element of danger, is pouring on naphtha or kerosene and setting a light to it. Another plan is to put the mould in the stove for 1½ to 2 hours if the mould is wholly in a "turn-over" box.

The illustrations on page 538 shew the best plan of all. For "drags" or bottom moulds the bottom of the fire pan is a plate with no perforations, and stick charcoal is the best fuel to use as it has little ash to hinder conduction of heat through the plate. If a crane is available the top part may be dried over the same fuel. If the crane is not available, then the top part, resting on stands, has the fire pan underneath. Fire pans for drying top parts have bars to carry the fire and in these gas coke may be used.

The advantageous use of skin drying has its limits. Where heavy cores have to be carried up on "chaplets" it will often be found preferable to make the mould in dry sand.

Cores.—The binding materials used in core making are legion; clay, dextrine or "gum," resin, flour, linseed oil, are some of the principal.



FIRE LAMPS FOR SKIN DRYING OF MOULDS.

A, wrought-iron bearer; C, iron plate 1/8 or 3/16 inch thick; B, sheet-iron cylinder; b, b, draught holes. All the parts are loose and inexpensive. The plate C is used in drag drying to keep cinders from falling into the mould.

Clay made into a wash of the consistency of thick cream is in universal use for making core sand suitable for large cores. If the cores are to skin or peel nicely, then a coating of black wash, preferably mineral blacking and clay water, is a necessity. When cores made of clay wash and sand with little or no coal dust or other carbon in it are used unblacked, the holes made by the cores are rough. This is due to the clay and sand forming a compound which fuses when the metal

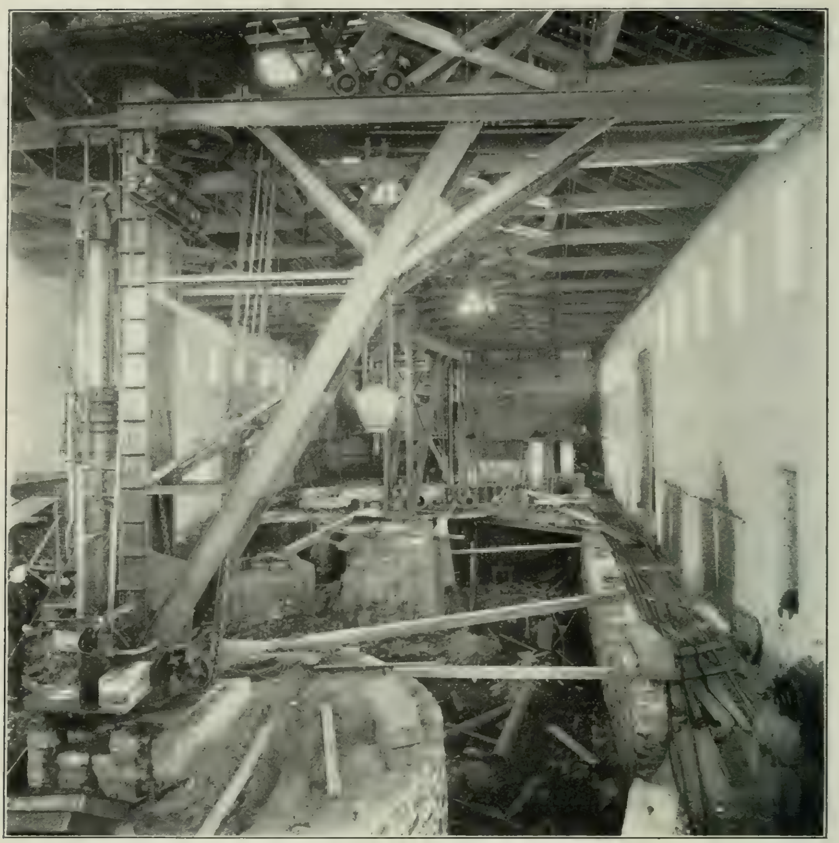
THE EAST BAY OF THE ALLIS-CHALMERS COMPANY'S WEST ALLIS FOUNDRY.
Showing general construction, lighting, and crane arrangement.

flows round the core, and forms the rough skin so much disliked by engineers, as it rapidly blunts the tools. If the cores are not required to leave a very smooth skin, then an addition of coal dust to the core, sand, or sand rich in carbon taken from the moulders doing light work, will save the work of black washing.

Where a large number of cores are used, sizes small to medium, core sand prepared as follows is difficult to beat.

1 barrow load burnt sand from the castings.
5 do do sand from the moulding floor.
1¾ pounds of dextrine or "gum" to each 3 hundred-weight of sand.

This mixture is damped and riddled and is ready for use. It dries into a core so hard as to be rubbed or "carded" with difficulty. Though



COMBINED HYDRAULIC AND POWER JIB CRANE.

Trolley and swing motions operated by gearing and clutches from belt-driven shaft or electric motor, hoisting by hydraulic power. Shown installed on a raised center of a casting pit. R. D. Wood & Co., Philadelphia.

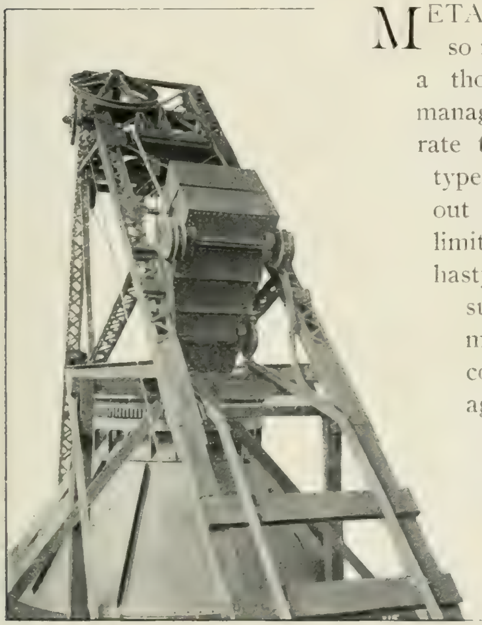
hard, the metal lies quietly on it unless too much gum be in the mixture. Some moulders keep a card for rubbing cores as part of their outfit and they use it on all and every occasion. The carding of cores may be a necessity now and again, as helping misfitting cores out of a difficulty, but in repeat work such botch work should be rectified.

The core maker by making his core sand of the proper sort can help to cheapen considerably the work in the dressing shop. The mixture given consists of practically pure silica. Silica is infusible and without bond. The gum supplies what the sand wants, but being volatile burns off when the metal surrounds the core, with the result that the cores simply drop out in the dressing shop.

# THE MANAGEMENT OF METALLIFEROUS MINES.

*By Albert Williams, Jr.*

In the following paper Mr. Williams takes up the management of metal mines as contrasted with that of collieries, so well discussed by Mr. Blackmore in THE ENGINEERING MAGAZINE for July and August, 1901, and purposely avoids repetition of points common to both fields. This first paper reviews briefly the widely differing kinds of metal mining, and offers suggestions as to a general line of policy applicable to the majority of cases. In a second article systems of organization will be compared, the relations between the business and technical ends defined, and the needed qualifications of superintendents and managers set forth. A third and concluding article will take up in detail the efficient organization of the technical staff.—THE EDITORS.



METALLIFEROUS mines differ so much among themselves that a thorough discussion of their management would involve separate treatment of each of many type groups, which is obviously out of the question within the limits of a single paper. Only a hasty glance at this phase of the subject is therefore here admissible. When we think of a colliery, a fairly distinct image is mentally formed; whatever minor variations exist, the mineral is substantially the same, the methods of finding the coal, of mining it, and of handling the product, have a family resemblance, and (what is more to the point) the establishment is always of considerable, often of very large, magnitude in order to be profitable—which means that a large force has to be directed and usually a heavy hoisting, pumping, and other plant to be operated. No such general conception of a metal mine is possible. Its product may be one or more of a wide range of minerals occurring in entirely different conditions, involving special methods of prospecting, mining, and subsequent treatment; the scale of operations may be anywhere between a coyote hole and a great low-grade mine employing hundreds of men; it may be a surface or a tunnel mine with little or no machinery, or it may be equipped with machinery capable of hoisting and pumping from a depth of 4,000 feet or more, to say nothing of the other highly specialized plant for treatment of the product. Furthermore, the commercial risks and the dangers to life and property are not the same in metal mines as in collieries. For example, the ventilation problem is a very minor one in the former class, while of prime importance in the latter.

The bearing of this is obvious. An anthracite-mine superintendent would soon feel at home in a Puget Sound soft-coal mine; so too would a North-of-England colliery manager. But one specially versed only in quicksilver mining would be rather lost in a big Lake Superior iron mine. Hence it is that there has been a gradual differentiation of mine managers, just as there is in the expert staff. A certain broadness of character and experience is most desirable; but it is well for young engineers to elect at an early stage which line of mining they intend to devote themselves to, and if well advised, the employers are largely guided in their selection of a superintendent by the latter's aptitude and previous experience in the particular branch of mining projected.

In considering the functions of a superintendent, then, it is necessary to note first the kind of mine he is to manage. The deposit is unchangeable, but there is a choice as to the man. Now the field may be looker at from several viewpoints:

To begin, as to the size and importance of the undertaking. If the mine is a very small one, a mere prospect perhaps, the owner often acts as his own superintendent—that is, if he is anything of a miner; if not, he hires some one familiar with the work in hand, preferably a practical miner used to the district. It would of course be foolish to employ a highly salaried superintendent to boss a single day-shift of two to half-a-dozen men. At the same time, there is plenty of room for skill and judgment in these small beginnings, and there are some precious-metal mines of "specimen" ore where there is working space for very few men to stope, but where the closest attention is required. A different case is presented when the small operations are possibly preliminary to important undertakings, as in prospecting known ore-bearing ground (by pits, tunnels, or diamond drill), with a view to determining the best mode of systematic attack; here the highest available acumen is demanded from the outset.

Perhaps the most exacting sort of mine to manage is one of medium size employing a crew of say twenty to fifty hands, which will not stand the expense of an expert staff. Such a mine ought to have, but cannot afford, specialists in all departments; yet the superintendent may consider himself lucky if he has one good underground foreman. He here finds his resources severely taxed, for he may have to combine in himself the functions of manager, assayer, surveyor, accountant and clerk, mill-man—and miner, of course—besides being occassionally called upon to lay out a surface road or a ditch, design a bunk house or mule shed, or install a plant. One eminent expert prided himself on having put up a roasting furnace mostly with his own hands, as there was nobody in the camp who knew how to set fire-bricks. The men did not call him "professor" after that.

The superintendent of a small or medium mine must always stand ready to take off his coat to tackle any odd job for which no one else is readily available; but it is a mistake to suppose that ability to strike an upper, or sharpen a drill, or put in a timber set, is more than an interesting though superfluous accomplishment under normal conditions, though he should know when these things are properly done. What is here said about the size of mine must naturally be modified according to its other characteristics. It may be a very simple proposition which a reliable former foreman could safely handle, or it might present very perplexing problems and involve multifarious operations calling for all-round technical skill.

In some respects a big mine—the bigness consisting in either the number of hands, the value of the product, or the scale and diversity of operations—is easier to run than one of the class just considered. The paradox is readily explicable. It is because the manager of a great mine is relieved of many details by his staff, and can devote his attention mainly to the larger questions of policy both as regards the mine itself and the business aspects of the enterprise. With competent assistants, it is not absolutely necessary that the manager himself should know how to do many of the things which they do for him; indeed, if he selects them judiciously, each should understand his own specialty better than the manager himself does. Certainly the superintendent cannot know too much; but that he cannot "know it all" goes without saying. What is here wanted is the man of affairs, not the specialist; if he has a fair general technical training, enough at least to supervise and gauge the work of his immediate subordinates justly, so much the better. And he should have a clear idea of a day's work of any sort.

Next as to the character of the mineral and its mode of occurrence. Various classifications have been given from the geological standpoint, but for the present purpose of illustrating the managerial requirements it is necessary only to group the mines very roughly and arbitrarily, taking into account the peculiarities of occurrence as they affect the methods of prospecting, exploiting, and disposal of product.

Placer deposits of gold and (rarely) other metals, such as platinum, form a class by themselves. It is only in the largest undertakings of this sort that the question of superintendence is of much moment. At some of the great hydraulic mines, now mostly extinct, however, a very high degree of professional ability has been shown, both in the direction of originality and daring and of extreme economy. (The record is 2.9 cents per cubic yard to cover expenses). This has involved the preliminary expenditure of large capital, good civil engineering, and a knowledge of hydrostatic and hdyraulics; but the management of the men, so few being employed, has been simple enough. Small workings, like ground sluicing, beach mining, etc., do not call for any special superintendence; and to run a gold dredger is much like the job of a contractor on harbor improvements.

Stream tin presents no special features and need not be here considered.

Other surface workings (apart from the "stripping" iron-ore mines of Minnesota and Alabama) are usually on the outcrops of veins and beds which are later mined underground. In their earlier development the work is simple, like quarrying, and generally on a small scale, though there have been exceptions such as the heavy gold-bearing outcrops of the Black Hills and Alaska where the managers had ample scope for their talent.

Veins of free gold, or mixed ores carrying free gold associated with sulphides or tellurides, and strictly refractory gold ores, form a pretty closely related group, the exploring and exploiting of which are conducted on well-understood principles; but on the metallurgical side important differences exist requiring special aptitude on the part of the manager, unless he relies on others.

"Straight" silver mines, that is, mines producing ores carrying silver as the only valuable content, are found in comparatively few localities, but some have been very productive (Aspen and some Mexican and South American districts, for example). Silver mines in which gold is an important item are more common. Both of these classes present very intricate problems to the mine manager, who should understand at least the outlines of economic geology and have a diversified experience—and even then will usually have to do much guessing and boring to locate an ore body. The treatment of these ores is also often a puzzle. It may be noted in passing that "free" silver mines (whose ore is worked raw by pan amalgamation) are practically obsolete, better metallurgical practice having changed their appellation and the methods of ore treatment.

Most of the silver and a noteworthy proportion of the gold now comes from base-metal mines and might be termed by-products, the mines being operated just as if these were merely lead or copper deposits (as the case may be). Hence are found two other classes of mines and two other sets of specialists. One group of mines comprises the lead-silver and the lead-silver-gold, and the other the copper-silver, copper-gold, and copper-silver-gold deposits.

Lead mines of another type include those whose ores do not carry enough silver or gold to be helped out financially by the value of these by-products, and in working them the manager has to keep in view economy rather than style. Lead ores are often associated with zinc or antimony ores; here a knowledge of the methods and appliances of concentration is required, and as these mines are generally small the superintendent has to run his concentration plant without expert assistance. Zinc mines proper come under the same head.

For large-scale of working and close economies there are few examples to be compared with the Michigan and Montana copper mines, which in this respect rival the iron and low-grade gold mines. As a rule, small copper deposits are not capable of profitable working, so that the bulk of the copper output comes from a comparatively few very heavy producers. The ores being usually low-grade (less than one-half of one per cent, or under ten pounds of metal per ton of ore at the record mine having been profitably worked, while five per cent. and upward is thought high-grade), a large and fairly regular ore body, permitting a steady supply, is essential; and this implies a numerous force, much machinery, and large quantities of supplies. The need of administrative ability is therefore imperative, and in the Lake district the custom has grown up of virtually separating the business from the technical functions, the "agent" relying upon the "mine captain" for the direction of the underground work and upon mill and smelter superintendents for the metallurgical part.

Somewhat similar, as to the manager's duties, are the iron mines. Under existing conditions small deposits of iron ore are commercially unworkable. It is only by handling a very heavy output that the small margin of profit per unit of bulk is made to count. A large part of the wonderfully close economy in getting the ore from the mine to the usually far-distant furnace (as was shown by Mr. James N. Hatch in THE ENGINEERING MAGAZINE for August, 1901) is due to ingenious ore-handling machinery and means of transit, but at the mines themselves a like progress has been made. At these mines mechanical engineering has full scope, while the business feature is naturally much in evidence. Manganese mining resembles iron mining, but the scale is smaller.

Quicksilver mining is a specialty requiring much local experience, and the successful superintendents have mostly been promoted from the skilled force at the several mines.

Mines of other metals than those mentioned are small and exceptional and do not demand special notice in this connection.

Another way of looking at the matter, in estimating the requirements of superintendents, is to consider whether the operations are purely or mainly those of mining, or are complicated by the addition of reduction plant belonging to the mine, located at or near it, and under a single head. What has just been said as to the character of the ore will in a measure indicate how a fresh classification of mines can be drawn. A free-gold mine almost always has its own mill; other gold mines are equipped with cyaniding, chlorinating, or concentration plant. Silver mines proper have their own mills or use custom mills in the neighborhood, or more commonly ship the product to lead-smelting works. Lead and lead-silver mines nowadays nearly always ship their ore to a central smelting center, to works operated under separate ownership, since the railroads have been pushed to almost all productive districts; sometimes they have concentrators on the spot. The ore shipped is sold outright on sample. The large copper mines have their own reduction plant at a convenient location within a reasonable railroad hauling distance and under the same general management.

The tendency in the United States has drifted constantly toward separating the mining from the reduction works, it having been found often cheaper to transport the ore even a long way (hundreds of miles in some cases) to points where it can be worked to best advantage, thus saving first cost of reduction plant to the mining company. This policy has to a large extent relieved the mine superintendent from the necessity of supervising the metallurgical work, it being possible in the case of many precious-metal, nearly all lead-silver, and practically all plain lead and zinc mines, to dispose of the product by shipping as run-of-mine, or after hand sorting or with a concentration treatment at the mines which does not make large demands upon the manager's attention. In the case of iron mines, even when owned by the iron and steel companies which turn out the finished product, the mine superintendent is always free from responsibility as to the smelters.

Still another factor is the location of a mine. If isolated, far from supplies, means of repair, local skilled labor, and with poor transportation facilities, the manager will often be left to his own resources and to save time must be ready with expedients in emergencies. If his field of duty is in a Spanish-speaking country he should know or acquire that language, if only in an imperfect manner.

It also makes a difference in the duties of a superintendent whether his mine is one employing little or no machinery, or has much of it. There are few large mines of the former class, for even surface mines may have extensive drilling or steam-shoveling and loading plant, while tunnel mines of any considerable extent are equipped with drilling, haulage, ventilating, and lighting appliances. To these the deep (shaft or incline) mines add the hoisting and pumping outfit, often very heavy. It would be desirable therefore for the superintendent of a mine equipped with much machinery to have at least a smattering of mechanical engineering, including the electrical, pneumatic, and hydraulic branches. Two very successful managers, it is recalled, were prominent mechanical engineers with no previous mining experience, who of course availed themselves of good mining and metallurgical assistance. Still, without this mechanical ability, the manager of such a mine might turn over the details of that department (giving it due prominence) to a specialist, reserving only a general control and supervision. The practice in the United States and in other countries supplied by American machine shops is for the latter to send out with the machinery, if of much extent, a man or a gang of men to install it and make sure that it is in running order. The shops regularly employ specialists for this purpose, and many send one to set boilers, another to line up shafting, others for placing special motors and machines, an electrician to arrange the wiring, and so on. Thus in the original installation the responsibility falls mainly on the contractors. But even before the selection of plant the superintendent may have the services of an independent consulting engineer; while the leading shops, for their own reputations' sake, give full information and advice which is generally reliable.

# THE EFFECTS OF WIND PRESSURE ON STRUCTURES.

*By Robert M. Neilson.*

As Mr. Neilson himself indicates in his opening paragraph, he is considering the subject of wind pressure on engineering constructions under conditions existing or to be expected in the British Isles. The fact, however, that his discussion is concerned with the general phenomena of wind motion and with the methods of investigation and deduction of formulæ, rather than with the determination of any absolute factors, gives the paper wide application. It is a comprehensive review of the best work that has been done in the field and a clear statement of some not very generally known facts.—THE EDITORS.

IT was the Tay Bridge disaster of 1879, more than anything else, that caused engineers in Great Britain to consider the effect of wind pressure on bridges and other structures. Previous to that event the consideration given to the subject was of a comparatively trifling nature. In fact, about the time of the introduction of iron-girder bridges it was thought by many that, if a bridge were strong enough to carry its own weight and its travelling load, it would be absurd to suppose that any wind pressure could rupture or overturn it. No attempt was therefore made in many cases to estimate the stresses caused by wind pressure or to provide for them in the design of the structure. Of course, it should be borne in mind that for the same factors of safety metal bridges were considerably heavier then than they are now.

After the Tay Bridge disaster, a committee was appointed by the Board of Trade to advise what provision should be made in future with regard to wind pressure. With the scanty data available at the time it is not surprising that some of the recommendations of this committee have not been supported by recent observations. One recommendation made by the committee and adopted by the Board of Trade was that structures in exposed places should be built to withstand wind pressures of 56 pounds per square foot, allowing a factor of safety for rupture of 4 for iron or steel and a factor of safety of 2 for overturning against the action of gravity. The fact does not seem then to have been much appreciated (although it was not unknown) that the action of the wind on large areas is very different from that on small areas. Pressures of more than 50 pounds per square foot have been indicated by anemometers or small registering gauges many times in Great Britain. Rankine gives 55 pounds per square foot as the greatest pressure observed in Britain, this being observed by Dr. Nichol of Glasgow Observatory. Fidler, however, mentions 65 pounds per square foot as having been registered on a gauge erected by the engineers of the Forth Bridge and, according to Bender, 71 pounds per square foot was recorded at Liverpool on September 27, 1875. We have no reason, however, for assuming that the average pressure on large areas is the same as on small. We have no record of a pressure approaching 56 pounds per square foot being actually measured as being exerted over a large area such as 100 square feet; and various observations made by different individuals have proved to us that in the observations in question the average pressure on a large area was different from that on a small one. Experiments were made at the Forth Bridge by exposing two gauges—one large and one small—to the same wind. The pressure per square foot exerted on the larger gauge, which measured 15 feet by 20 feet, was only from 60 to 70 per cent. of that exerted per square foot on the smaller gauge, which was only 1½ square feet in area. There are many bridges and other structures now existing in different parts of Britain which were erected at a time when it was not the custom to allow much or anything for wind pressure and which could not withstand a pressure of anything like 56 pounds per square foot.

Sir J. Wolfe Barry made experiments on wind pressures on the Tower Bridge. A bascule of this bridge furnishes about 5,000 square feet of area and Sir J. Wolfe Barry calculated from the power required by the actuating engines, that, while small anemometers on the fixed parts of the bridge adjoining the bascules registered 6 pounds to 9 pounds per square foot, the wind pressure on the bascules was only 1 pound to 1½ pounds per square foot.[*]

That wind pressure per unit area decreases with the extent of the surface was noted in the eighteenth century by several experimenters, including De Borda and Hutton. The results got by De Borda in one set of experiments are given in the following table:—

| Surface in square inches. | Intensity of pressure. |
|---|---|
| 9 | 100 |
| 16 | 109 |
| 36 | 119 |
| 81 | 129 |

There are two reasons why the average intensity of pressure on a large area should not be so great as on a small area. In the first place, the average velocity of wind is very much exceeded by local currents in the same wind. One of these local currents, striking the full extent of a small area, will cause a high pressure, while it will make little difference to the average pressure on a large area. In the second place, the flow of air is very much upset in the case of a large surface by the lateral flow of the air from the front of the surface, and the velocity of the air for a considerable distance in front of the large surface (or rather, the component of this velocity at right angles to the surface) is probably much reduced.

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[*] See THE ENGINEERING MAGAZINE, Nov., 1898, page 289.

Mr. T. Seyrig has tabulated the particulars of a number of railway cars and wagons of the Southern Railway of France which have been overturned by the wind. From these particulars it results that the pressure exerted by the wind must have been from 26 to 34 pounds per square foot. It is noteworthy that in every case recorded there were other vehicles in the same train which would have required higher pressures to upset them and which were not upset. There were also wagons which were thrown off the rails and not upset; but, as the wind pressure to accomplish this cannot be satisfactorily ascertained, these cases need not be considered. Professor Gaudard also has given particulars of the upsetting of trains in France—in this case between Narbonne and Perpignan—from which it appears that the pressures were from 30 to 50 pounds per square foot. It should be noted that this is a particularly stormy locality.

We have, therefore, fair grounds for the belief that the wind pressure on large areas need never in Britain be expected to approach 56 pounds per square foot. Constructing a bridge or other large structure to withstand a wind pressure of 56 pounds per square foot with the usual factors of safety, seems therefore to be incurring an unnecessary expenditure. If a structure is arranged to withstand an overturning moment due to a wind pressure of 56 pounds per square foot and has a factor of safety of 2, it will require a wind pressure of 112 pounds per square foot to overturn it. Now the maximum ever experienced in Great Britain is probably well within a third of this. It must also be noted that a mere puff of wind will not overturn a massive structure. In the instance just given a momentary pressure of even 112 pounds would in most cases not suffice; a continuous blast would be required to overcome the inertia.

The allowance for 56 pounds per square foot wind pressure is a serious matter with large bridges. Sir Benjamin Baker has calculater that, in some of the members of the Forth Bridge, the maximum forces due to dead load, live load, and wind pressure are as follows:—

| | |
|---|---|
| Dead load, | 2282 tons. |
| Live load, | 1022 tons. |
| Wind | 2920 tons. |

It will be seen that the force allowed for wind pressure almost equals the dead load and live load put together and it must be remembered that the provision for wind pressure is responsible for some of the dead load. Sir J. Wolfe Barry in his address to G section of the British Association in 1898 said:—

> "It is difficult to imagine the amount of money which has been wasted in unnecessary provision against wind strains of 56 pounds per square foot on large areas in consequence of this hurried generalisation from insufficient data. I know something of what the provision for 56 pounds on the square foot for wind cost at the Tower Bridge, and I do not wish to mention it: but if the public had been told that the dictum of experts arrived at, however hastily, in 1880, was to be set aside in the construction of that bridge all confidence would have been beforehand destroyed in it and I suppose no Committee of Parliament would have passed the Act."

Fidler considers that wind which will exert a pressure for overturning carriages of 30 pounds per square foot will record on a dynamometer a pressure of 40 to 75 pounds per square foot. Anglin is of opinion that for large areas it is sufficient to assume a maximum pressure of 45 pounds per square foot over the whole surface. Still it cannot be said that we have reliable information as to how much to allow for wind pressure on bridges and buildings. Much time and labour have been spent on experiments, but knowledge useful to engineers is still far from complete. Since the days of Sir Isaac Newton there have been many experimenters on wind pressure. The French general Didion did much in this way, and among others may be mentioned De Borda, Robins, Rouse, Vince, Edgeworth, Rumford, Piobert, Thibault, and Hutton. As however different experimenters used different apparatus, there is a great want of uniformity in the results obtained. I may here give a few of the many formulæ that have been proposed at one time or another for calculating the wind pressure from the velocity of the wind.

Rouse's formula is

$$p = \frac{V^2}{200}$$

where p denotes pressure in pounds per square foot and V velocity in miles per hour. This formula was adopted by Smeaton (it is sometimes called Smeaton's formula) and has been used to a considerable extent.

Didion's formula in British units is

$$p = 0.0036\ V^2$$

the letters representing the same as in Rouse's formula. Didion's formula gives considerably lower pressures than Rouse's.

A formula of modern date is that of Mr. W. H. Dines who based it on the result of lengthy experiments carried out at Hersham in Surrey. Dines' formula is

$$p = V^2 \times 0.003$$

the letters representing the same as in Rouse's and Didion's formulæ. Dines' formula gives slightly lower results than Didion's.

Hawksley's formula is

$$p = \frac{v^2}{20}$$

where p denotes pressure in pounds per square foot and $v$ velocity in feet per second. This formula is based on scientific reasoning, but the assumptions made are quite unwarranted. This formula gives higher pressures than any of the others here cited. The results of the four formulæ are compared in Table III. As, however, the pressure on a large area has been shown to be different from that on a small area for the same wind velocity, these formulæ are obviously of little use for general application.

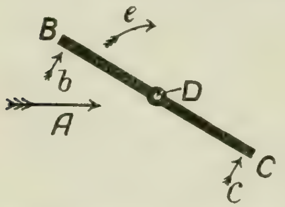

FIG. I. EFFECT OF WIND PRESSURE ON INCLINED PLANE.

Besides the question of total pressure it is important to know how the pressure is distributed over a structure. It seems to be evident from numerous experiments and observations that, when a plane surface is inclined to the wind, the pressure is greater at the forward than at the rear end. That is to say, if A, Figure 1, represents the direction of the wind, and B C is a plane exposed to the wind pressure, the normal pressure exerted on the plane at B as represented by the arrow *b* is greater than the normal pressure exerted on the plane at C as represented by the arrow *c*. If therefore the plane be pivoted at its centre D (the pivot being normal to the paper) it will tend to rotate in the direction of the arrow *e*, till it lies at right angles to the direction of flow of the wind. This explains why a throttle valve pivoted about a diameter in a steam pipe tends to close with a flow of steam.

Some interesting experiments were made about seven or eight years ago by Mr. J. O. V. Irminger, engineer and manager of the municipal gasworks at Copenhagen, and Mr. H. C. Vogt of the same city. The draught from a chimney 100 feet high was used to draw air through a duct measuring about 9 inches by 4½ inches. This is

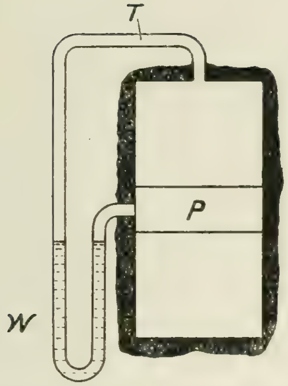

FIG. 2. APPARATUS FOR MEASURING WIND PRESSURE.

shown in section diagrammatically in Figure 2. A plate P 1⅝ inches broad was extended across this duct and was so fitted that its inclination could be altered at will. This plate although flat was hollow and its interior, by means of a trunnion, was put into communication with one leg of a water gauge W, the other leg of which, by means of the tube T, communicated with the interior of the duct. The plate P was provided with several holes. Only one hole was left open at a time, the others being stopped, and the pressure inside the hollow plate was assumed to be equal to the pressure exerted on the plate in the region of the hole. The water gauge indicated the difference between this pressure and the pressure in the duct. The experiments showed, not only that the pressure near the forward edge of the windward side of the plate when the latter was inclined was greater than that near the rear edge (the fact which has just been mentioned with reference to Figure 1), but also that the normal pressure near the forward edge was considerably greater when the plate was inclined at 45 degrees than when at 90 degrees to the direction of air flow.*

The fact is fairly well established that the pressure on the inclined roof of a house is greater near the eaves than near the ridge, and some experiments would lead us to believe that there may even be a negative pressure near this ridge, as shown in Figure 3, where the large arrow indicates the direction of the wind and the small arrows indicate by their length and direction of pointing the intensity and sign of the normal pressure on the roof. The phenomenon of negative pressure is not at all inexplicable, if we consider the probable motion of the air over the roof as shown in Figure 4. Experiments and observations have shown that there may be and probably always is a negative pressure or upward

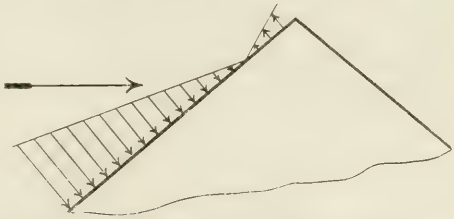

FIG. 3. ILLUSTRATING WIND PRESSURE ON A ROOF.

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* See THE ENGINEERING MAGAZINE, July, 1899, page 671.

suction over the top of a gas holder during a heavy wind. Of course it will be understood that this is only relative to the ordinary atmospheric pressure as measured by a barometer. Mr. Irminger of Copenhagen, by means of a registering pressure gauge, ascertained that during a wind that varied from 29 to 70 feet per second the pressure inside a gas holder 170 feet diameter and 90 feet high fell from 6.25 inches to 5.83 inches. This is equal to a lifting force of 2.2 pounds per square foot on the top of the holder. Everyone is familiar with the corresponding upward pull exerted by a strong wind on an umbrella.

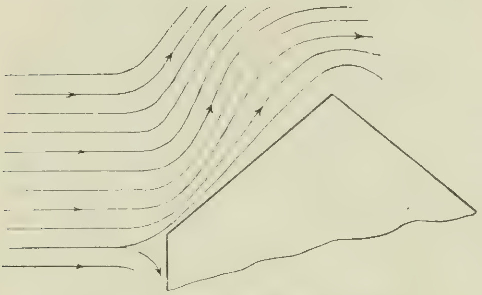

FIG. 4. WIND STRIKING A ROOF.

The nature of the pressure on a cylinder with a vertical axis is important, as this is the form of many structures which have to be constructed to withstand the wind. Experiments show that the positive pressure on a cylinder due to wind pressure extends over less than half its circumference (some experimenters put it at less than a fourth), the rest of the circumference being subjected to a negative pressure. Figure 5 illustrates this, the large arrow indicating the direction of the wind and the small arrows the intensity and sign of the pressure on the cylinder. This diagram is intended however only to give an idea of the nature of the pressure on the cylinder and not to be correct quantitatively. For this we require further experiments. The experiments of Berthon seemed to show that the suction at the sides of the cylinder was greater than at the back, the intensity of pressure being somewhat as shown in Figure 6.

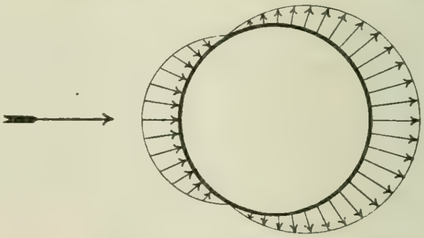

FIG. 5. DIAGRAM ILLUSTRATING THE WIND PRESSURE ON A CYLINDRICAL BODY.

Another important matter of study in connection with wind pressure is the relative resistance to the wind offered by bodies of different shape. A round chimney is generally suposed to offer less resistance to the wind than a square one of equal height and equal capacity. This can be deduced from De Borda's experiments and from general observations. What is the ratio of the resistances is however a question which can hardly be said to be settled.

Rankine gives the formulæ

$$P = ps \text{ for a square chimney,}$$

$$P = p\frac{s}{2} \text{ for a round chimney,}$$

where P denotes the total pressure against the chimney (presumably in the line of motion of the wind), s denotes the area of a diametrical vertical section of the chimney (presumably at right angles to the line of motion of the wind) and p the greatest intensity of pressure of the wind against a flat surface (presumably normal to the wind). According to Rankine, therefore, the resistance of a square chimney with one side facing the wind is to be taken as double that of a round chimney whose diameter equals the side of the square chimney. A round chimney of equal horizontal section to the square one would then have a resistance of 56 per cent. of that of the square one.

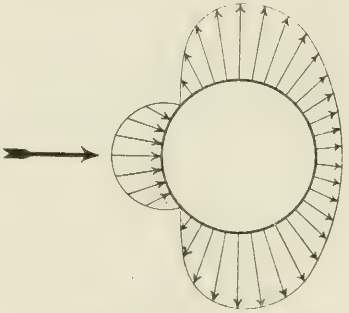

FIG. 6. DIAGRAM ILLUSTRATING THE WIND PRESSURE ON A CYLINDRICAL BODY.

Trying to arrive at a result by calculation is not of much use unless we know how the air acts on the square and on the round chimney respectively. This we know very little about. If we make certain assumptions, we can by theory find the relative resistances of bodies of different forms. For example, if we assume that wind consists of a series of small particles uniformly distributed and travelling all with the same velocity in parallel paths, and if we assume that when the particles strike a fixed body the angle of incidence is equal to the angle of rebounding, and if we further assume that the particles on rebounding never collide with each other, then the pressure P on a flat surface normal to the wind will be given by the equation

$$P = 2Adv^2$$

where A denotes the area of the surface, $v$ the velocity of the wind, and $d$ the density or mass per unit volume.

With the same assumptions the pressure on a cylindrical surface (such as a round chimney) would be $1\ 1/3\ Adv^2$ and that on a sphere would be $Adv^2$. In the last two cases A is the diametrical section of the body, that is, the product of diameter and height in the case of the cylinder, and $\pi$ and the square of the radius in the case of the sphere.

According to this reasoning the resistance of a round chimney would be 1 1/3 × 56 per cent., or 75 per cent. of that of a square chimney of equal height and horizontal section. Making the same assumptions, the resistance of a square chimney with its sides at 45 degrees to the direction of the wind would equal $Adv^2$ where A is the section across corners. The resistance of the chimney in this position would therefore be $1/\sqrt{2}$ of the resistance when set square with the wind, that is, rather less than the round chimney of equal capacity.

But however little we know of wind pressure we are certain that the assumptions we have made are not only unwarranted but impossible. The calculations are therefore of little value except for mathematical study. We have however learned experimentally a little about the relative resistance of bodies of different shapes. De Borda's experiments showed with small bodies the pressure on a sphere was 0.41 and that on a cylinder was 0.57 of that on a flat plate. A few years ago M. Le Dantec made careful experiments with falling bodies of different shapes. The bodies were guided to fall vertically, the guide, which was a tightly stretched wire, being practically frictionless. The times of starting, stopping, etc., were automatically recorded on bands of moving paper and other precautions were taken with a view to obtaining great accuracy of measurement. Some interesting and valuable results were obtained. The bodies when let go of course started to fall with an acceleration; but a critical velocity was reached in each case at which the resistance, which varied with the square of the velocity, was balanced by the force of gravity. The velocity thereafter was uniform.*

A square plate of one metre side moving at a velocity of one metre per second was found to encounter a resistance of 81 grammes. Plates of equal area but of different shapes—circles, triangles, etc.—were found to encounter resistances which were nearly proportional to their perimeters, the circle having of course the smallest perimeter and therefore the smallest resistance. The fact already mentioned as having been proved, namely, that large areas offer proportionately less resistance than smaller ones, agrees with M. Le Dantec's experiments, as the perimeters of large areas are relatively less than those of small and similar ones.

M. Canovetti has made experiments somewhat similar to those of M. Le Dantec. M. Canovetti however caused his bodies to move along an inclined wire. The horizontal distance between the ends of the wire was 280 metres and one end was 71.2 metres above the other. The inclination of the wire varied slightly owing to sagging. Times were taken by a stop watch and some of the results obtained are given in the following table:—

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* See THE ENGINEERING MAGAZINE, Oct., 1899, page 122. Also *Bull. Soc. d'Encouragement*, July, 1899.

M. Canovetti's experiments with falling bodies.

| Form of body. | Pressure in grammes. |
|---|---|
| Circular plate; area one square metre | 80 |
| Rectangular plate; area one square metre | 90 |
| Hemisphere with convex side foremost; area of diametric section of sphere one square metre | 22.5 |

In all cases the velocity was one metre per second.

It may be assumed that the average pressure on a body will be much the same whether the body is moving and the air at rest or the body at rest and the air moving. Fidler however says that "it has not yet been ascertained that the pressure of the wind is the same thing as the resistance offered by the air to a moving body." The pressure in the one case will of course vary much more than in the other.

The following table compares the results obtained by several experiments and formulæ for a certain area and a certain velocity:—

Results obtained by different experimentors, and formulæ of the pressure on a circular plate of one square metre at right angles to wind travelling at 1 metre per second.

| Formula or experiment. | Pressure in grammes. |
|---|---|
| Rouse's | 122 |
| Didion's | 88 |
| Dines' | 73 |
| Hawskley's | 131 |
| Le Dantec's | 72 |
| Canovetti's | 80 |
| Perfect impact* | 249 |

It is well-known that a body of umbrella shape offers a great resistance to air moving against its concave side. This fact is made use of in the parachute, and windmills are constructed on this principle. According to General Didion the resistance of a parachute whose depth is one-third of its diameter is about double that of a flat circular plate of the same diameter. This fact is also borne out by the experiments of Hutton.

The total force exerted by the wind on a plate is of course the sum of the positive pressure on the windward side and the negative pressure on the leeward side. For example, if the pressure on the windward side of a plate of 1 square foot area is 50 pounds above atmosphere and that on the leeward side 26 pounds below atmosphere, the effective force on the plate is $50 + 26 = 76$ pounds. The experiments of Du Buat and Thibault seemed to show that the positive pressure on the windward surface of a plate was double the negative pressure or suction on the leeward side. Other experiments however lead us to believe that the relative values of positive pressure and suction depend on the shape and inclination of the plate.

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* That is according to equation near the bottom of page 553.

The effective force on a plate is found not to be the same as on a prism whose ends are formed by two such plates, the wind pressure being perpendicular to the plate and to the ends of the prism. In spite of the skin friction on the sides of the prism, the effective force on the latter is less than on the plate. This does not seem unnatural when we consider that the air striking the plate or the end of the prism will be projected laterally and will be able to close in again behind the prism much better than behind the thin plate. There will therefore be greater suction behind the plate than behind the prism.

In many cases it is desirable not only to know the total effective force on a body, but the pressure and suction on its front and rear sides separately. Thus in a house it is necessary to have each wall strong enough to stand the wind pressure or suction (whichever is greatest) as well as to have the house constructed to resist being swept away as a whole. The same thing holds good in box girders or tubular bridges. It should be noted that a wind gauge which consists of a plate which is exposed both front and rear will register a pressure which is the sum of the pressure on the windward side and the suction on the lee side.

The question of the pressures on two parallel plates having a space between them not laterally enclosed is also important. Two such plates occur as the girders of a plate-girder bridge. Baker's experiments with equal parallel discs are interesting in this connection. The total effective force on the two discs was found to be as given in the following table:—

| | | | | | |
|---|---|---|---|---|---|
| Distance apart in terms of diameter.......... | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 |
| Total effective force in terms of effective force on single disc by itself.................. | 1.0 | 1.25 | 1.4 | 1.6 | 1.8 |

As there must be a certain amount of force exerted on the leeward disc, it follows that the effective force on the windward disc is reduced by putting behind it at a distance of a diameter another similar disc. That is, not only does the windward disc shield the leeward one, but the leeward disc shields the windward one. And this is what one would naturally expect on a little consideration; for the air between the discs must be comparatively still and suction on the back of the windward disc be very little. In the case of plate-girder bridges, therefore, we may assume that the effective force on the windward girder will be less than if it were alone, and the effective pressure on the two girders will depend on the relation between their heights and their distances apart.

We know that in a gale the velocity of the wind is constantly changing. The maximum pressure recorded by a small gauge therefore will not as a rule measure the force to which a structure is subjected. The small inertia of the gauge will enable it to register the maximum force reached during a puff, but a few feet or even a few inches away the pressure at the same moment may be less. Besides this the maximum pressure may last for only an instant. That is to say, the pressure due to a puff of wind may increase to a maximum and then decrease. For example, at Greenwich on January 16th, 1872, the average pressure for each separate hour of six consecutive hours varied from 2.8 to 3.6 pounds per square foot; but the maximum pressure each separate hour was from 30 to 42 pounds per square foot. Now a light gauge will register the very maximum, while the heavy body will be affected only by the average pressure during a small period of time. Consider for example the stability of Cleopatra's needle on the Thames Embankment. We could easily find the uniform wind pressure which would be required to overturn it, but a sudden small gust which merely reached that intensity for an instant would not effect the result; there is more than the weight of the stone to be overcome—there is the inertia. This fact is well illustrated by the way that windows are blown in by gusts of wind which seem to make no impression on the buildings containing the windows when, by calculation, the windows in many cases ought to stand a greater steady pressure than the building.

A series of comparative tests with gauges which require different amounts of work to make them record would be very interesting and instructive. We might employ spring-actuated plate gauges with large and small masses, or we might cause the pressure on equally massive plates to act on water gauges having large and small sections of tube.

It should be noted that gauges are often affected by buildings or erections in the vicinity and do not register the pressure that would exist in the open. We all know how seriously the draught of chimneys is affected by adjacent objects. It has been suggested that comparatively feeble gusts of wind might rupture a structure if the period of the gusts was equal to the natural period of vibration of the bridge. But the probability of this occurring for more than two or at most three consecutive gusts seems so remote that its effect beyond this possible maximum periodicity may be neglected.

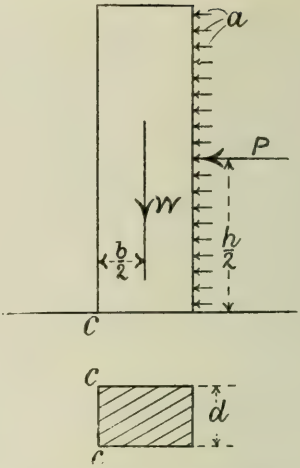

FIG. 7. DIAGRAM ILLUSTRATING THE STABILITY OF A COLUMN.

A large structure is more stable than a small one of a similar shape and nature. That is, it takes a greater wind pressure per square foot to overturn a large structure than to overturn a smaller one of the same shape and the same density, if the structures rely on their weights only to resist overturning and if the material is not ruptured. Consider the column shown in Figure 7, which we will suppose to be of rectangular cross section and to have a height *h*, a breadth *b* and a thickness *d*. Let *w* be the weight of a unit volume of the material of which the column consists. The small arrows *a* represent a uniform wind pressure of *p* pounds per unit area. The large arrow P represents the resultant wind pressure on the column acting at a distance of ½ h from the ground. The large arrow W represents the weight of the column which acts through its centre of gravity, the line of W being at a distance of ½ b from the back of the column. Let us take moments about the edge *c, c.* The overturning wind pressure will be such that the moment of P equals the moment of W.

$$\text{therefore} \quad P \times \frac{h}{2} = W \times \frac{b}{2}$$

$$\text{but} \quad P = hdp$$

$$\text{and} \quad W = hbdw$$

$$\text{therefore} \quad hdp \times \frac{h}{2} = hbdw \times \frac{b}{2}$$

$$\text{therefore} \quad hp = b^2w$$

$$\text{therefore P} \quad = \frac{b^2w}{h}$$

For columns of similar shapes *b* varies as *h*, and therefore *p* varies as one of the linear dimensions. Therefore, if a wind pressure of 20 pounds per square foot is required to overturn a column 20 feet high, a wind pressure of 40 pounds per square foot will be required to overturn a 40-foot column of the same material and similarly proportioned. If the 40-foot column had a base equal to that of the 20-foot column, instead of being proportionately greater, then the same wind pressure would overturn both. This applies to bodies of any shape.

Figure 8 shows three columns similar except for their bases, which are equal. These columns are equally stable.

This fact may be expressed by the following rule:—

*For equal stability against wind pressure, similar bodies require equal bases and not similar bases.*

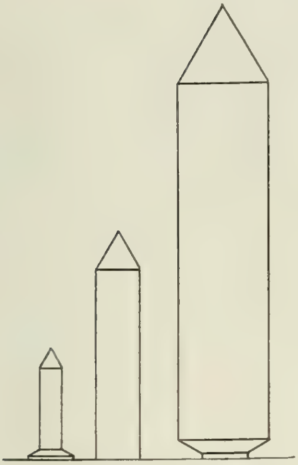

FIG. 8. ILLUSTRATING EFFECT OF SIZE ON STABILITY.

The bases, relatively very different, give equal stability against wind pressure.

This rule must be taken as approximate only, for there are several considerations which we have left out of account, such as skin friction of the wind on the sides of the structure, the effect of the friction of the ground on the wind pressure on the front lower part of the structure, and the greater intensity of wind pressure on small than on larger areas. The rule, however, is roughly speaking correct and explains why in nature an insect has such a large leg base and a large quadruped proportionately such a small one.

We asumed in considering the stability of the column shown in Figure 7 that it would tilt about the edge *c*. We did this because we were considering stability given by weight only, and not considering the strength of the material. In some cases the material would not fracture and the structure would tilt as has been shown. In other cases the material about the tilting edge would crush. This crushing would not affect the overturning moment, but it would reduce the moment of stability and therefore lessen the wind pressure that the column would stand.

This article will not be complete without a few words on tornadoes. We are not troubled with tornadoes in Great Britain, but in America they occur every now and again and contrive to do a maximum of damage in a mimimum of space and time. The destructive power of some of these tornadoes has been terrific, but happily their track is usually very narrow and it seems the wisest course as a rule not to attempt to construct buildings to withstand them but to take the chance, which is really extremely small, of a tornado ever striking them. At a meeting of the American Society of Civil Engineers, the widths of the tracks of several tornadoes were given. The Marshfield tornado was 1,800 feet wide, the St. Charles tornado not more than 60 feet, and the Medford tornado had a track only about 13 feet wide.

It is not in the province of this article to discuss the cause of tornadoes. The cause however involves a low barometric pressure at some place, and this affects the nature of the destruction caused by the tornado, and the nature of the provisions to withstand it if such provisions are to be made. In some cases damage seems to be done by suction. In the tornado or cyclone or "vacuum storm," as it has been very appropriately called, which swept through the cities of St. Louis and East St. Louis on the evening of May 27th, 1896, there were unmistakable signs of damage having been done by a sudden fall of pressure. Walls of houses in many cases fell outwards, evidently due to the excess of pressure inside the houses when the pressure outside was suddenly reduced. The capacity for harm of a sudden fall of pressure will be evident when we consider that every inch of mercury equals a pressure of 70.7 pounds per square foot. If therefore the barometric pressure were suddenly reduced outside a building by an inch and a half, the walls of the house would be subjected to the enormous pressure of 106 pounds per square foot. Several houses were found after the St. Louis tornado with walls intact but with the lath and plaster torn off the ceilings of the rooms immediately below the attics. In these houses there was no flooring on the attics, and the only explanation of the phenomenon seems to be that, when the vacuum wave passed the house, the excess of pressure in the rooms got out by windows or flues or otherwise, but that in the case of the attics with no adequate air exits, the excess of pressure of the imprisoned air burst down the ceilings of the rooms below. In many cases in which the outside walls of houses were in part thrown down (outwards), light partitions and light furniture were left unmolested, showing that there had been no violent air currents inside the house.*

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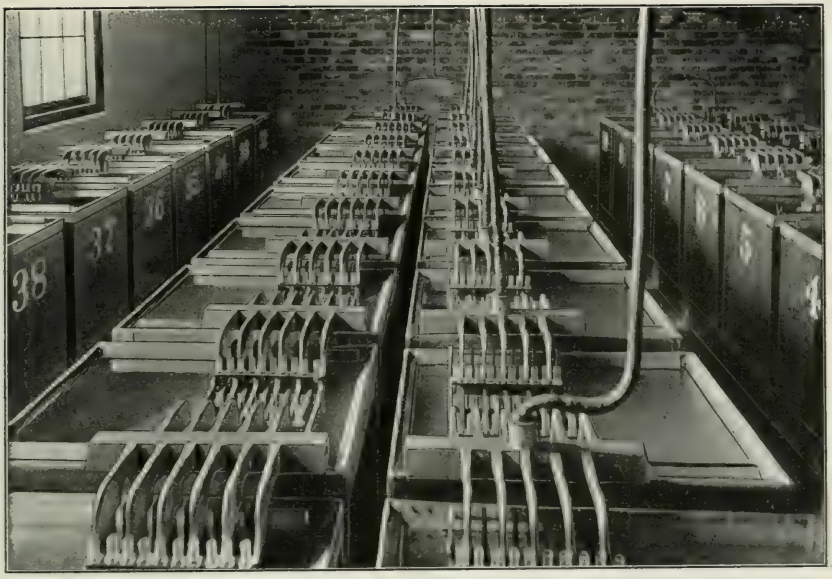
* See paper of Mr. Julius Baier, Pro. Am. Soc. Civil Engineers, Jan., 1899.



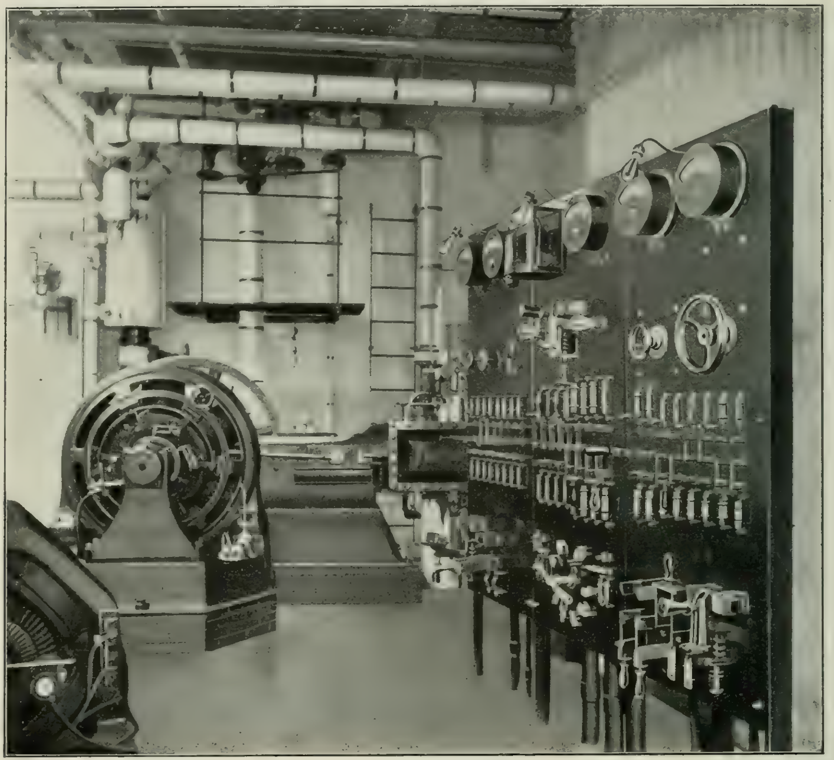
A Chloride Accumulator Plant.

# ECONOMY IN THE DESIGN AND OPERATION OF ELECTRIC PLANTS.

*By Percival Robert Moses.*

A NUMBER of articles on the general subject of isolated electric plants have appeared in THE ENGINEERING MAGAZINE, the majority having for their theme a more or less detailed study of the comparative cost of electricity from this type of plant and from the central station. Anyone studying the figures carefully must have been struck by the wide dissimilarity in the results from different plans having the same general characteristics, and it is the purpose of this article to point out some of the ways in which economy in operating cost may be obtained.

It is well to bear in mind the fact that operating expense is not fuel and labor cost only, but includes fixed charges, repairs cost of water, oil, and sundries, which in the aggregate frequently exceed the cost of either fuel or labor and sometimes of both together. The ad-



BOOSTER AND SWITCHBOARD, PLANT OF HASTINGS SONS PUBLISHING CO., LYNN, MASS.
In connection with 200-ampere chloride accumulator installation.

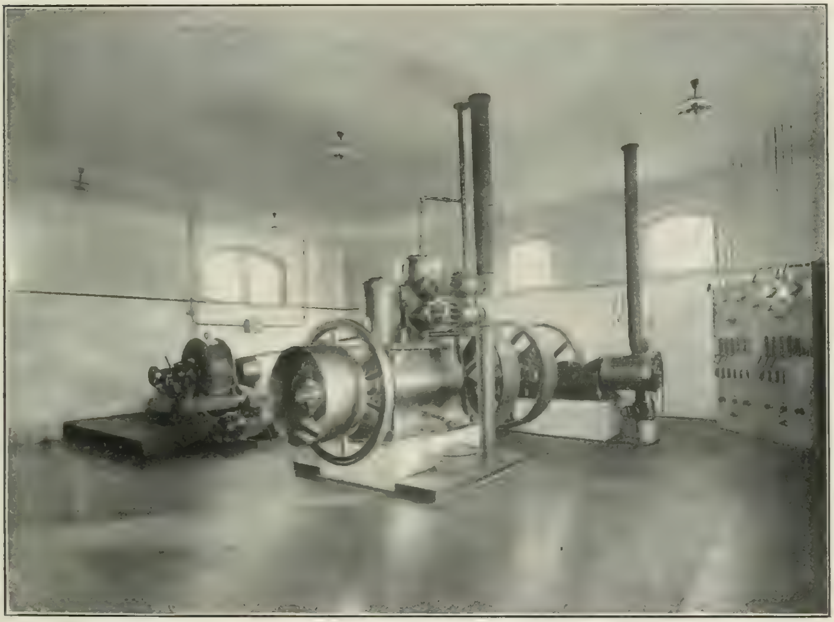
mirable papers written by Mr. Isaac D. Parsons and published in this Magazine for January and February, 1902, brought out clearly the importance of these items, particularly that of fixed charges. The largest plant described in these papers was also the most costly per unit of power delivered—a result contrary to all reasonable anticipation, and due in great measure to excessive first cost and consequent high interest and depreciation charges.

In this connection the following quotation from Wellington (The Economic Theory of the Location of Railways,) adapted to this subject, is apropos:—

> "No increase of expenditure over the investment minimum is expedient or justifiable, however great the probable profits and value of an enterprise as a whole, unless the increase can, with reasonable certainty, be counted on as a good investment."

If this were framed and hung above each consulting engineer's desk, it is certain that the investment, in this case, at least, *would* be both "expedient and justifiable." The most frequent cause of extravagant installations is found in the fact that sufficient return is obtainable upon the whole expenditure to warrant the investment, and the lack of returns from a number of more or less important items making up the grand total is overlooked.

On the other hand, again quoting from Wellington, no *saving* of expenditure is expedient or justifiable when it can be counted on with reasonable certainty that the additional expenditure at least would in itself be a paying investment. This is to be qualified by the proviso that the additional expenditure can never be a profitable one if it endangers the successful completion of the plan as a whole.



MAIN GENERATING PLANT FOR BILTMORE, THE ESTATE OF GEORGE W. VANDERBILT, ESQ. Two Hodge boilers of 125 and 100 horse power; Ball & Wood engine belted to a General Electric 60-kilowatt 2,300-volt monocyclic generator, and Westinghouse engine belted to a similar unit. Transmission of three miles to transformer station near Biltmore House. Used in connection with storage battery shown on page 571.

It is not possible in a paper of this character—nor, in fact, in any thing short of a book—to treat fully of plant costs and methods of reducing operating expense, but a few facts gathered from practice may be of use.

The basis of design of plants must be cost, as in the end that plant which will give the best results at the least cost is the one to be installed. We must therefore begin our consideration of the subject by establishing some definite cost data. Table 1 below shows actual costs of boilers installed. Water-tube boilers differ largely in price for different types. Those listed are the "B. & W." type.

| Type | Size in horse power. | | | | | |
|---|---|---|---|---|---|---|
| | 60 | 80. | 100. | 125. | 150. | 300. |
| H. T. for 100 lb. pressure... | $850 | $900 | $1,050 | $1,250 | $1,300 | ......... |
| H. T. " 125 lb. " ... | 950 | 1,000 | 1,100 | 1,150 | 1.400 | ......... |
| Water-Tube .............. | | $18 to $23 per h. p. | | | $15 to $18 per h. p. | |

TABLE I. COST OF BOILERS FOR ISOLATED ELECTRIC PLANTS.

Table 2 shows the actual cost of engines and standard sizes. The costs of high-speed engines are for direct-connected units and include metallic packing, tools, sub-base, shaft and outboard bearing for dynamos, and erection in cities near New York. It is particularly interesting to note that three engines of 80 horse power each cost the same as one of 225 horse power, and that two 125-horse-power engines cost $300 less than one of 225 horse power. This is contrary to the usual belief, and has an important bearing on the design of small plants, as it allows division of the equipment into a number of units without increased—and frequently with decreased—first cost, incidentally making the installation reliable, flexible, and efficient.

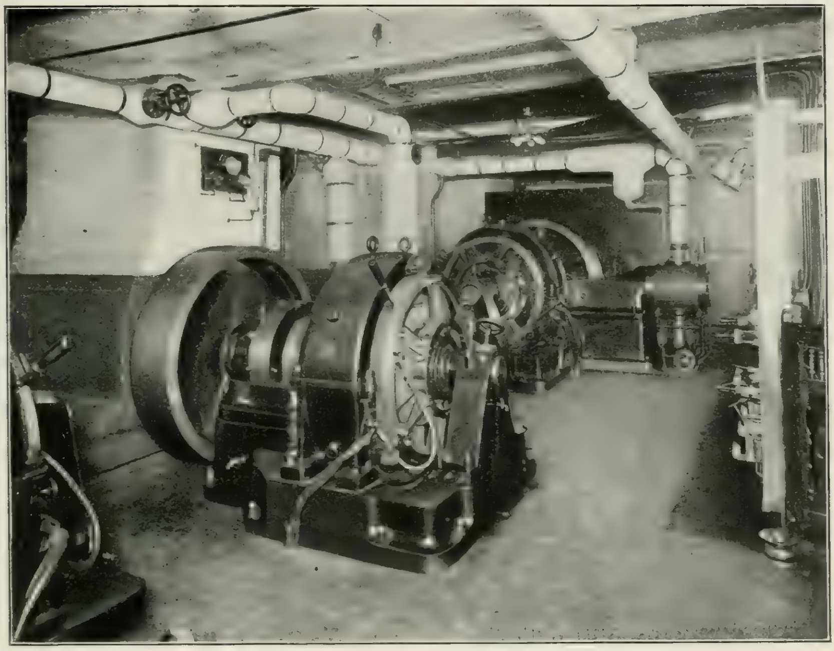
| Type. | Size in horse power. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 40. | 60. | 80. | 100. | 125. | 175. | 225. | 300. |
| High-speed, simple ....... | $900 | $950 | $1,200 | $1,250 | $1,600 | $2,200 | $3,500 | .... |
| " " compound ... | .... | .... | .... | 2,600 | 3,000 | 3,250 | 4,000 | 4,500 |
| Simple Corliss ........... | 1,350 | 1,800 | 1,900 | 2,000 | 2,200 | 2,900 | 3,600 | 4,900 |
| Compound Corliss ....... | .... | .... | .... | .... | .... | 3,600 | .... | 6,000 |
| Simple, four-valve ....... | .... | .... | .... | 1,650 | 2,000 | 2,850 | 3,400 | 4,200 |
| Compound, four-valve ... | .... | .... | .... | 2,650 | 3,050 | 3,800 | 4,250 | 5,000 |

TABLE II. COST OF ENGINES FOR ISOLATED ELECTRIC PLANTS.

There is another point to be mentioned in connection with the table of engine costs, viz., that the cost of the sizes of engines shown is not dependent on the steam pressure, provided this is 80 pounds or more: for although a 10-inch engine with 125-pounds pressure and an 11 or 12-inch diameter cylinder will indicate more than 80 horse power, the frame of the 10-inch engine is not designed to carry this load and it is generally necessary to use the 12-inch frame with a cylinder of small diameter. This is not true with a few makers, but it is the rule.

No figures are given for high-speed engines arranged for belting. Those given for direct-connected units may be used, the cost of sub-base, etc., being balanced by the belt and belt-tightening arrangement.

Where belting is permissible a Corliss or four-valve engine is advisable, as economy, life, and reliability are gained.



GENERATOR PLANT, ASTOR BUILDING, N. Y.
Two 50-kilowatt and one 75-kilowatt direct-connected units, 115 volts. Used in connection with storage battery shown on page 570.

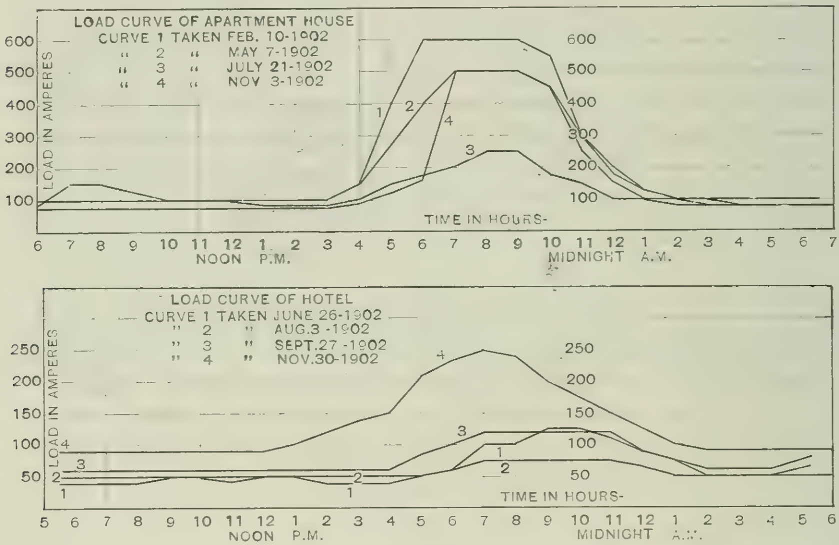
Table 3 shows costs of various kinds of dynamos. The variation in price is similar to that of engines; the small sizes up to 100 kilowatts cost from $23 down to $15 per kilowatt. Above this size the cost per kilowatt does not decrease materially, making it entirely possible to put three 100-kilowatt dynamos for the same price or less than one 300-kilowatt machine.

| Type. | Size, kilowatts. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Direct Current. | 25. | 30. | 40. | 50. | 75. | 100. | 150. | 250. | 300. |
| Multi-polar, direct-connected ......... | $550 | $650 | $850 | $1,000 | $1,300 | $1,500 | $2,750 | $3,750 | .... |
| Multi-polar medium speed belted ....... | 425 | 600 | 750 | 900 | 1,100 | 1,200 | .... | .... | .... |
| Alternating current 2 or 3 phase belted.. | 750 | ... | ... | 1,400 | .... | .... | 2,750 | 3,800 | 4,750 |

TABLE III. COST OF GENERATORS FOR ISOLATED ELECTRIC PLANTS.

The relatively smaller cost per unit of size of the smaller machines is due to the fierce competition of manufacturers, and is made possible by the small investment required for tools and shops. The larger units demand special tools, heavy cranes for handling large parts over a large area, and more capital tied up, preventing the decrease in shop cost which might be expected with increased size.

With these figures as a rough basis the design of the plant for economy becomes easier; it involves a load curve showing the amounts of power and light that will have to be supplied during different hours of the day. After this is plotted the plant should be divided into as few units as will enable the boilers, engines, and dynamos to work at or near their maximum economy, and at the same time provide a sufficient number so that in the event of the breakdown of one the others will be capable of carrying the load. The limit of size of one of the units is generally fixed by the day load—principally power: the total plant capacity is fixed by the maximum possible load, and the size of the other units by the maximum probable load. A number of load curves of buildings were shown in the papers referred to and a few more are given below.



TYPICAL LOAD CURVES OF A HOTEL AND OF AN APARTMENT HOUSE.

A casual study of the load curves of an apartment house, an apartment hotel, or an office building, shows a very light load, from one-fifth to one-fourth of the maximum, during three-fourths of the time, and a heavy load during the remainder, approaching three-fourths of the total capacity connected to the lines. This would indicate a small unit (for day work) and two large units, the sizes to be such that either of the large units (together with the small one, in emergencies) could supply the demand for the heavy-load period; ordinarily the two large ones would run together in heavy-load periods.

Where electric elevators are installed another factor is introduced through the starting current required and the small average running current. On this page is shown a load curve of a building without elevator load, and above it a typical elevator load curve with an average requirement of 15 kilowatts for light and power and a momentary maximum of 60 kilowatts. If good service, noiseless operation, and long life are essential in a plant of this character, it is necessary with the standard-design engine and dynamo to install a unit for such work having a capacity of at least the "average maximum," if such a term is permissible. If this is done the plant can not be economical in steam consumption, as during four-fifths of the time the engines are running at but 10 to 15 per cent. of their rated capacity, and during the remainder at rapidly and continually varying points of cut off and rates of expansion.

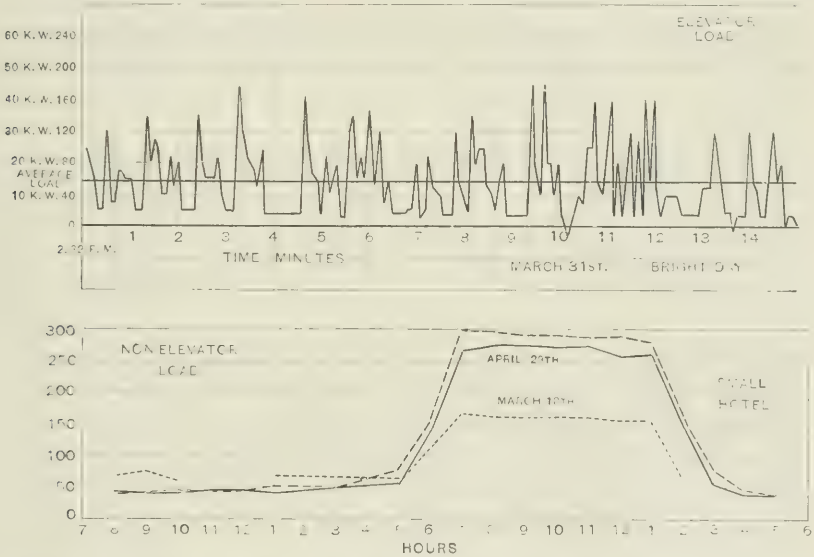
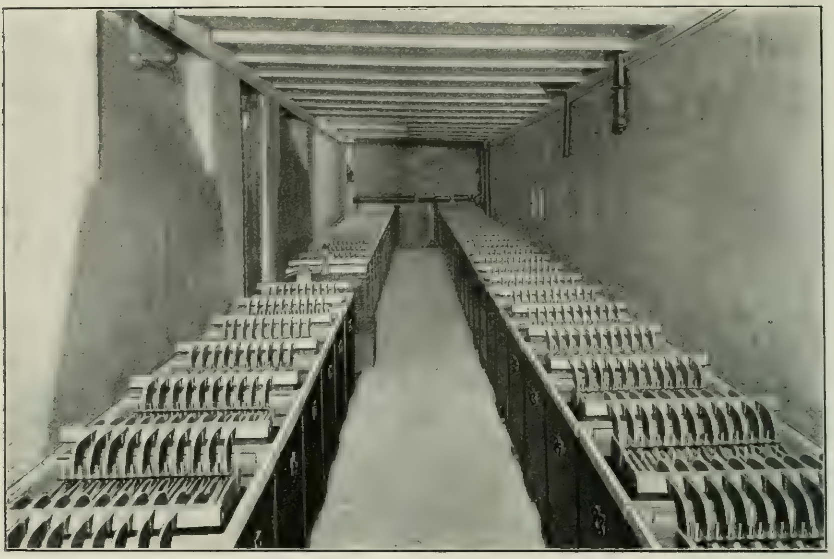


DIAGRAM OF LOAD-CURVE OF A BUILDING WITHOUT ELEVATOR, AND OF A TYPICAL ELEVATOR LOAD CURVE.

The remedy for this state of affairs is found in some method of storing energy, and the only one which has received practical development, as yet, is the electric storage battery. Other methods have been proposed, but not yet developed in working form. This auxiliary to the plant is useful mainly in two ways, one of which is to equalize the load by receiving and delivering electricity (i. e., charging when the elevators are not drawing more than the average current, and dis-



STORAGE BATTERY ROOM, ASTOR BUILDING, N. Y.

60 chloride accumulators, having capacity of 200 amperes at nominal discharge rate. Electric Storage Battery Co.

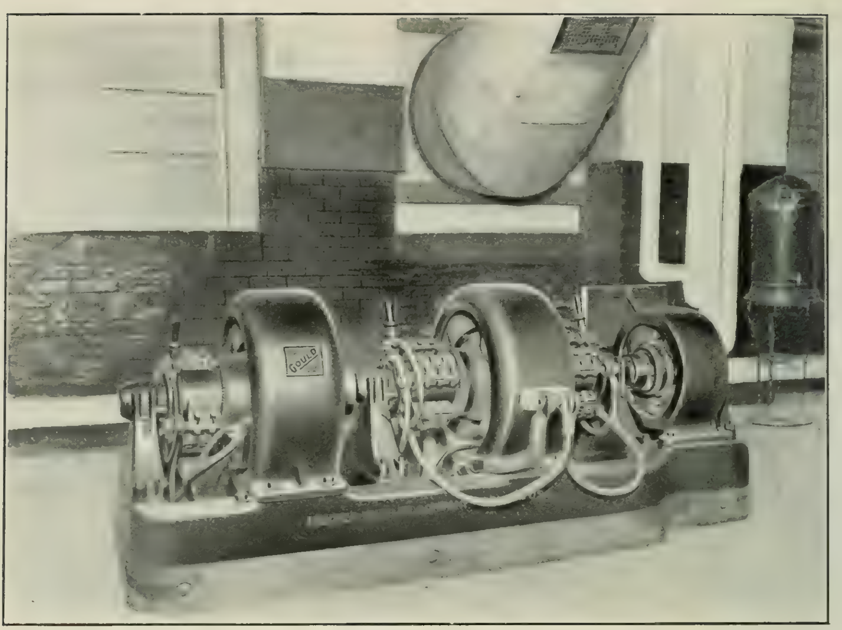
charging when more than the average is required) and the other is to supply all the elevator and lighting current required during light-load periods. There is a third use, viz., to supply the peak of the load during the heaviest lighting period; but the excessive cost of storage batteries for large quantitative discharges, compared to the cost of engines and dynamos, prevents their use for this purpose except in instances in which the heavy load is of very short duration, as in some office buildings and factories.

The cost of storage batteries is their only real drawback when operated under intelligent supervision. It varies from $11 per ampere hour for small batteries of 240 ampere-hours capacity, or $8 per ampere hour for 500 ampere-hours capacity, to $7.50 per ampere hour for several thousand ampere-hours capacity. These capacities are based on an average discharge for eight hours at 120 volts. These figures include constant-current booster, or similar automatic regulating device, and switchboard, but no wiring. Where elevator current is to be supplied, the cost of the battery is largely offset by the saving in boiler, engine, and dynamo equipment.

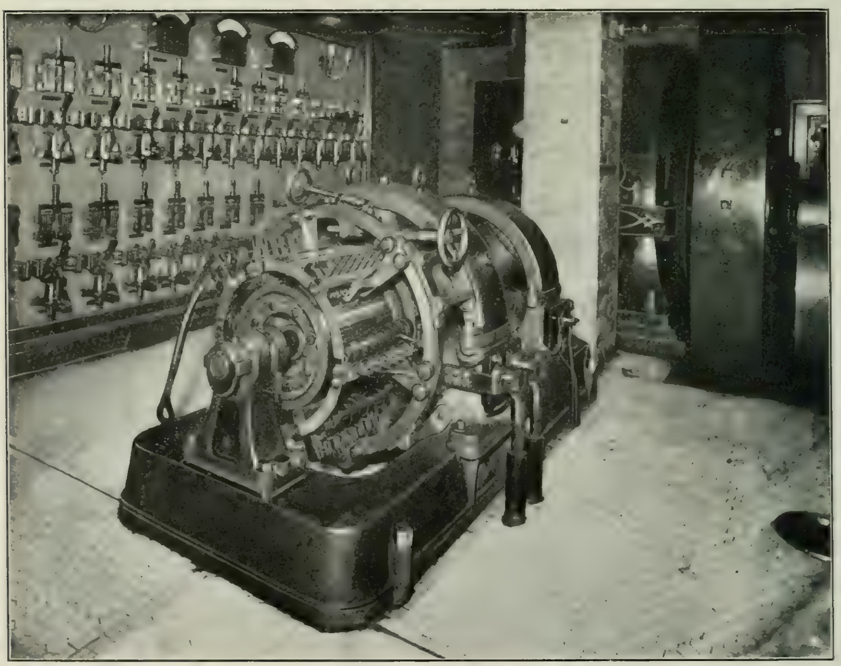
In a plant recently designed, the cost of the engines and dynamos required where no storage battery was used, (two large generating units and one small one) was $10,200; and the cost of the engines and dynamos required with a battery was only $7,900. The price of the battery was $4,000, making the net cost of its installation only $1,700. With the first design, the smaller engine would run constantly during light load at about 15 per cent. of its full capacity, with momentary requirements of 100 to 125 per cent., requiring from 15 to 20 pounds of coal per kilowatt hour delivered under actual working conditions; and the plant would have to run at all times. Under the second plan no engine would run after one o'clock at night, nor in the daytime in mild or hot weather, and at other times the plant would operate at from one-half to three-fourths rated capacity, using from 6 to 10 pounds of coal per kilowatt hour. These figures are deduced from a large number of daily records kept for a period of several years in a number of plants. The efficiency of a storage battery is not high—from 70 to 80 per cent.—but this is of small consequence, as it applies only to that portion of the current it discharges. Usually this is from 5 to 10 per cent. only of the total current supplied by the plant, so a loss of 20 per cent. in passage through the battery would be only from 1 to 2 per cent. of the total power supplied.

THE BILTMORE BATTERY ROOM, SHOWING ARRANGEMENT OF CELLS.

60 Gould cells, capacity 2,000 amperes at 8-hour rate. Cells glass covered to prevent loss and exclude dust. Gould Storage Battery Co.



BOOSTER IN THE COLLIER BUILDING, NEW YORK.
Capacity of 400 amperes at 30 volts. Used in connection with 56-cell Gould storage battery.



BOOSTER AND SWITCHBOARD, EXCHANGE COURT BUILDING, N. Y.
In connection with Electric Storage Battery Company's chloride accumulators.

Besides the reduction in operating expense, a battery offers numerous inducements, among them steady lights, free from fluctuations, a reserve capacity in case of accident to the steam main or shut off of water supply, and absence of noise or heat when the electric plant is shut down.

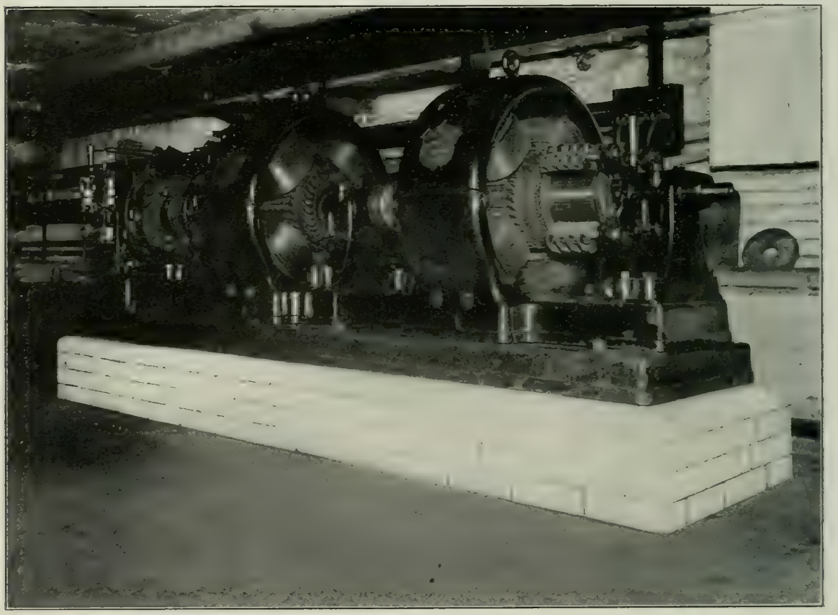
Another point in the design of electric plants where large wastes are usual and avoidable is in the grates for boilers and the methods of fuel burning. Cheap fuel well burned is more vital to the cheap production of power than any economy that can be introduced in the design of the engines or other machinery. If fuel at $1 to $2 per ton can be burned to give results one-half as good as fuel at $3.50 to $4 a ton, more saving will result than there will from a reduction in steam required per indicated horse power in the engine from 35 pounds to 25 or 15, as any saving in the cost of making steam reduces the cost of operating all types of apparatus using it, whether they are pumps, boilers, ice plants, or engines, while an increased economy in one particular type of apparatus saves only while that apparatus is in operation.

STORAGE BATTERY, COMMERCIAL CABLE BUILDING, NEW YORK.

62 Gould cells. Capacity 80 amperes for 8 hours, 160 amperes for 3 hours, 320 amperes for one hour.

Several systems for burning low-grade fuels and waste products are in operation, among them bagasse and saw-dust burners, waste-gas boilers, and blowers combined with pin-hole grates and special settings for the lowest grades of anthracite, such as rice, barley, and screenings, costing from $1.50 to $2.25 per ton under normal conditions. In a test on one plant, different grades of anthracite from pea down to screenings were tried with different grates and appliances. Boilers side by side were operated under identical conditions over extended periods, and screenings were finally adopted with the use of a patented system of burning. The cost with this grade of coal per pound of water evaporated was less than one-half that with the largest size tried. Such systems, however, should be used only after careful investigation, as a great many are of no value or are so complicated as to make them a nuisance.

A third economy, less important except where refrigerating machinery is installed, is in the water supply. Whether water is purchased or pumped it costs something, and in cities it is an important item in the expenses of a plant. The water required for steam costs in New York about 25 or 30 cents per ton of coal burned under the boiler; one-fifth of this or less may be saved by using an open feed-water heater and returning water to the boiler; the remainder can be saved only by use in the heating system or by a condenser, and this latter is impracticable unless accompanied by a cooling tower or by

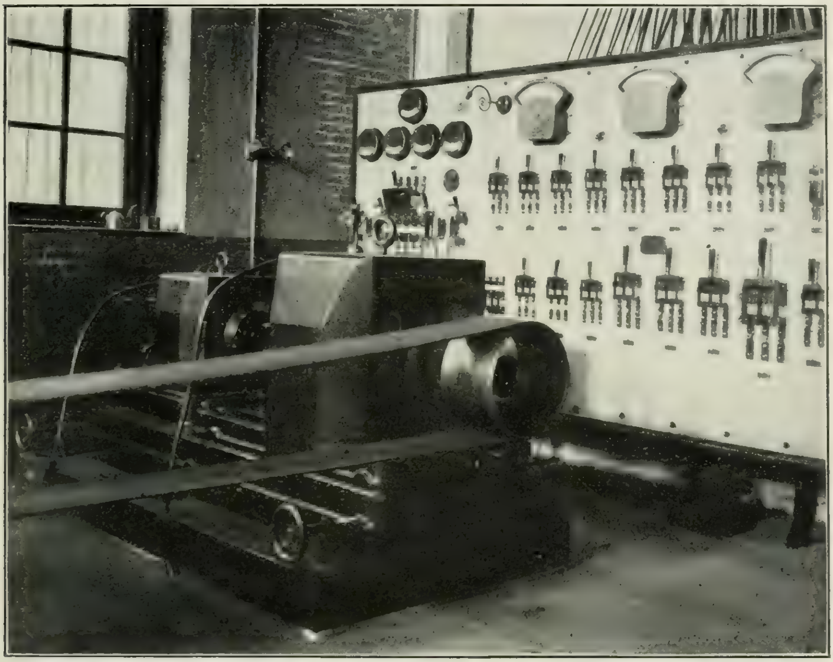


BOOSTER IN COMMERCIAL CABLE BUILDING, NEW YORK.

Used in connection with the storage battery shown on page 573.

available salt water. The cooling tower will waste more water than the steam condensed, so that from the point of water saving it is not valuable; the accompanying reduction of steam consumption in the engine, however, makes it worthy of careful consideration where its installation is feasible.

The open feed-water heater is a money saver when water is expensive, provided it is accompanied by an efficient grease extractor and a properly designed pump. If oil is allowed to enter with the steam and is fed to the boilers, or if the pump is not fitted for hot water and placed sufficiently below the heater to avoid hammer, the saving in water is counterbalanced by leaky boilers and noisy pumps. When refrigeration is an important part of the plant, and water is expensive, either the water must be used for other purposes, or some method must be adopted of cooling and re-using it; otherwise its cost is greater than that of the coal for operating the plant.



GENERATOR AND BOOSTER AT BILTMORE, DRIVEN BY 3-PHASE INDUCTION MOTOR.

A fourth economy, which has been treated fully in other papers* and which space will not permit the discussion of here, is the more or less complete use of the waste or exhaust steam from engines for

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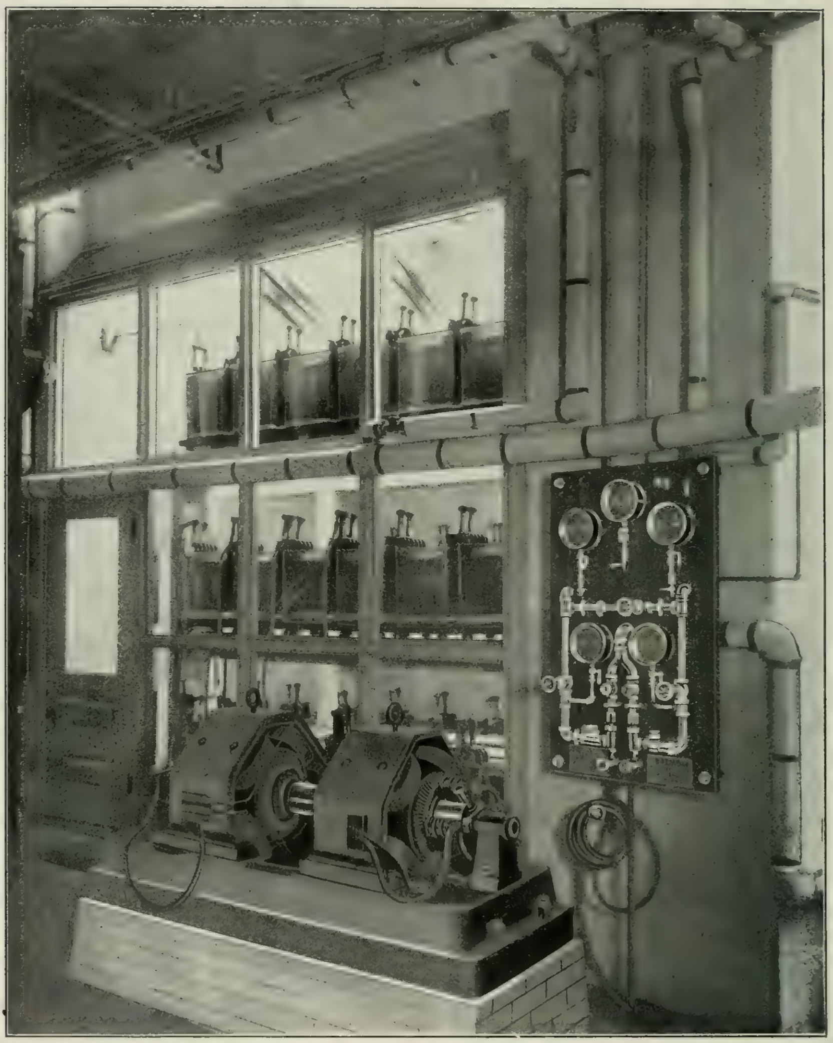
* The Centralisation of the Steam Condensing Plant. H. G. V. Oldham, in THE ENGINEERING MAGAZINE for October and November, 1900.



A RESIDENTIAL PLANT—BOOSTER, CHLORIDE ACCUMULATORS, AND SWITCHBOARD.

heating, boiling, or similar moderate-temperature applications. Where all the exhaust derived from a plant can be used, an economy closely approaching perfection is obtained which cannot be equalled by any other form of engines. The use of exhaust steam for distillation, for sugar making, and dozens of other manufacturing applications is well known, and it is along this line rather than along that of engine development *per se* that the greatest savings of the future will be effected.

# COST FINDING METHODS FOR MODERATE-SIZED SHOPS.

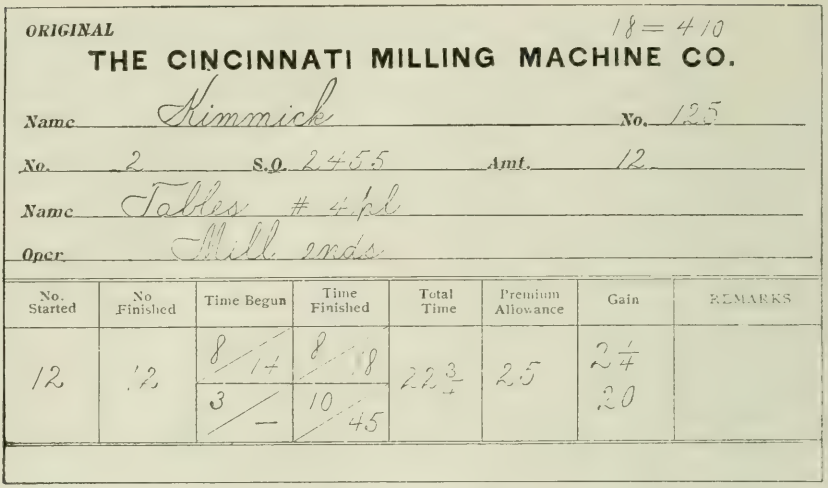
## A SUCCESSFUL EXAMPLE UNDER THE PREMIUM WAGE SYSTEM.

### *By Hugo Diemer.*

The series of cost-keeping articles of which this is the second paper began in our preceding issue with an exposition, by Mr. H. L. Arnold, of the methods of the Bigelow boiler-manufacturing company. The purpose of every one of the articles will be to furnish a working description of a practical system, in actual use in a shop where it has stood the test of time and been proved successful and sufficient. The reproduction of the forms and blanks in immediate connection with the explanatory text makes the papers particularly useful and interesting to those who are concerned in the introduction or the working of methods of shop accounting.—The Editors.

DURING the past few years numerous discussions of the premium wage system have appeared in technical literature. Practical examples of cost finding and stock tracing under the system have not been so numerous. The methods adopted in its successful introduction into a flourishing machine shop are herewith outlined.

The Cincinnati Milling Machine Company employs from three hundred and fifty to four hundred workmen in the manufacture of milling machines, grinding machines, and attachments. The number of different parts manufactured aggregates about four thousand, and the distinct machine-shop operations on each part vary from four to thirty. Since the beginning of the past year the company has been establishing premium pay rates, beginning with certain operations on which available data and experience enabled them to set the time allowance with confidence as to its correctness. The system is constantly being extended to cover further operations, the intention being to have a definite time set on every separate standard operation. Two men act as time keepers. These men spend their entire time in making circuits of the factory and filling out the slips shown in Figure 1. There is a nail or hook convenient to each man's place of work on which hangs a book of these tickets. The first ticket is issued on Monday morning is given No. 1, and they are numbered consecutively until closing time on Saturday. The tickets are written in duplicate, and each man's duplicate tickets, showing his premium earnings, are returned to him with his premium pay.



ORIGINAL 18 = 410

THE CINCINNATI MILLING MACHINE CO.

Name Kimmick No. 125

No. 2 S.O. 2455 Amt. 12

Name Tables # 4 pl

Oper Mill ends

| No. Started | No Finished | Time Begun | Time Finished | Total Time | Premium Allowance | Gain | REMARKS |
|---|---|---|---|---|---|---|---|
| 12 | 12 | 8/14 | 8/18 | 22 3/4 | 25 | 2 1/4 | |
| | | 3/— | 10/45 | | | 20 | |

FIG. I. TIME TICKET.

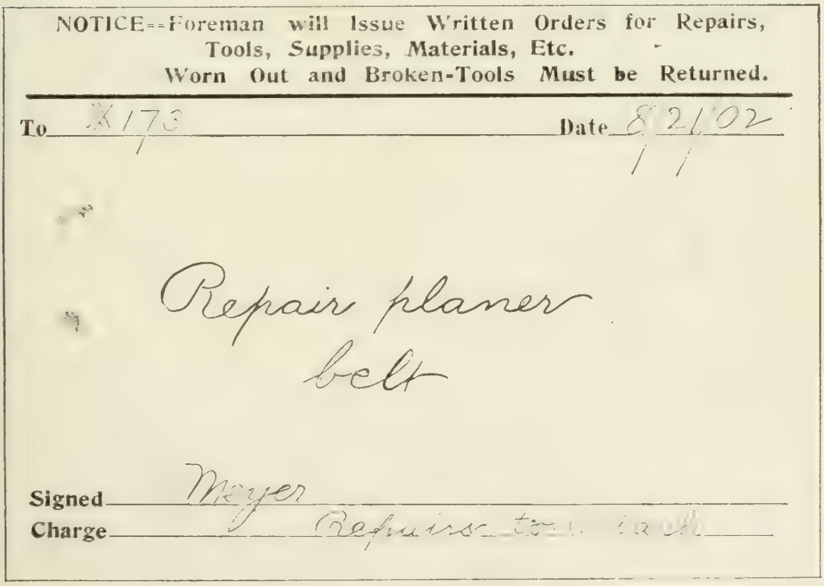
**The actual card is somewhat larger—6 by 3½ inches—of thin white paper. The duplicate (marked "Duplicate" in upper left corner), folds under this by a perforated bottom edge.**

The employment of special men for writing out the time tickets has been found far preferable to having the men or foremen fill out tickets themselves. It was calculated that if each man spent ten minutes in filling out time tickets, daily, it would amount to an hour per week. For a fifty-seven-hour week, the value of this time would be one fifty-seventh of the total pay-roll, or one fifty-seventh of about $3,000, a considerably greater sum than the time-keepers' wages, with the disadvantage of no uniformity and very little reliability. The time clerks are young men of about thirty years of age—mature enough to know how to get along in a factory. They are expected to get all the data they need with the least possible consultation of the workmen. Much of their information is obtained from the shop-order tag or tracing slip, which will be explained more fully later, and is shown on page 585.

If in the interval between the time-keepers' consecutive visits to any one workman that man has stopped work temporarily on one order on which he has been working (and for which the time keeper has written say ticket No. 4), and has completed some short orders and returned again to work on order represented by ticket No. 4 when the time keeper next passes him, the time keeper issues a ticket giving it the next consecutive number—in this case No. 5—for the short job done, and notes on the back of the ticket No. 4 covering the order which was temporarily discontinued "(Date), Deduct —— hours —— minutes, time ticket No. 5."

These interruptions are usually on "foremen's orders," a blank form of which is shown in Figure 2. If work on an order which has been begun is to be discontinued for some time, owing to the arrival of some hurry order, the workman's time ticket is marked "unfinished," and turned in with the tickets for finished work. Unfinished tickets are posted on cost cards in pencil and then filed temporarily in a card-index drawer until the "finished" ticket comes through, when the entries are made in ink.

The "job" or "time" tickets are turned over by the time keepers to the pay-roll clerk who makes from them entries on monthly sheets (a sheet for each man), shown in Figure 3. He checks up the total time reported on tickets against the time as shown by the strip from the clock register. He notes on each time ticket the workman's rate, and extends the labor cost and premium gain where there is any. He uses a rate sheet mounted on a substantial board, with vertical and horizontal guide to assist in his calculations. The board is mounted on a drawing stand by his side so as not to interfere with his desk work. The monthly sheets show each man's time losses as well as his gain,



NOTICE==Foreman will Issue Written Orders for Repairs,
Tools, Supplies, Materials, Etc.
Worn Out and Broken-Tools Must be Returned.

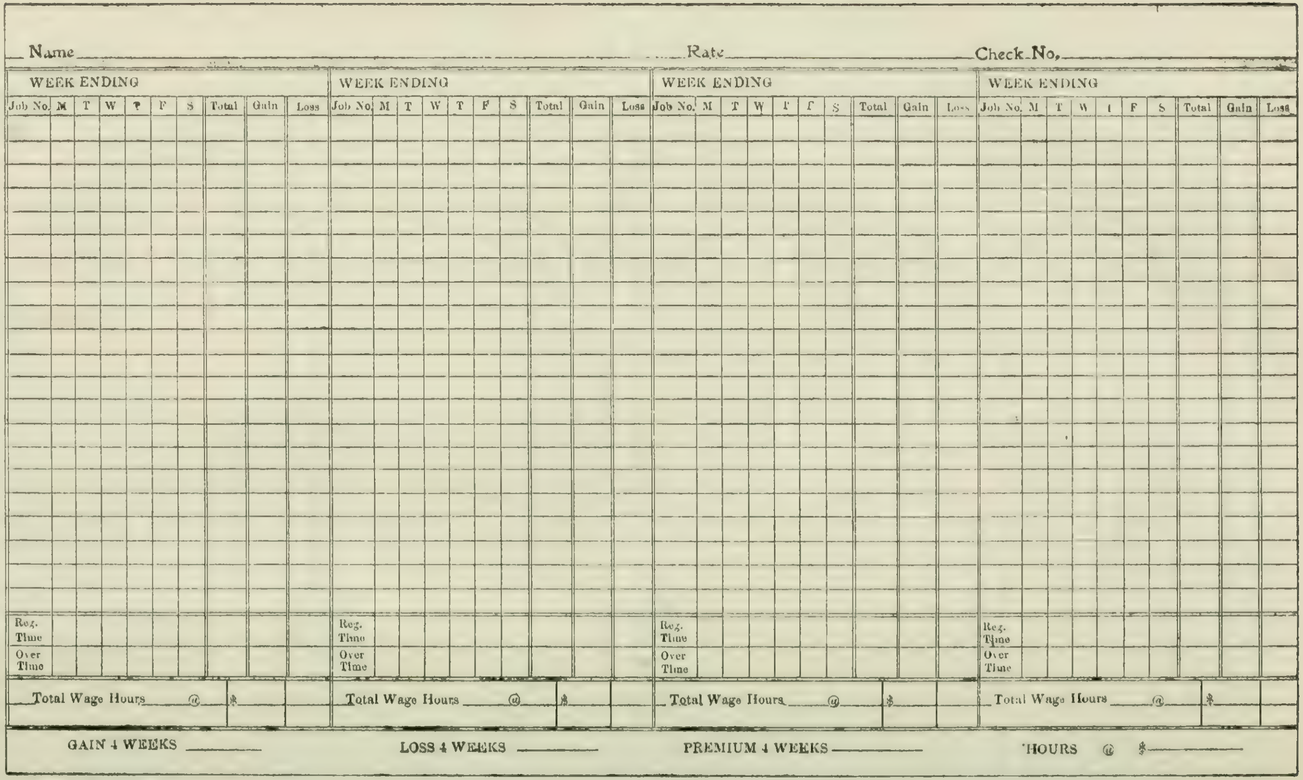
To X173 Date 8/21/02

Repair planer
belt

Signed Meyer
Charge Repairs to [illegible]

FIG. 2. FOREMEN'S ORDER.

Printed repetitively on a roll of white paper. Width as shown. In use, the form gives a little more space for entries, being 5 inches high.



Name ______ Rate ______ Check No. ______

| WEEK ENDING | | | | | | | | | | WEEK ENDING | | | | | | | | | | WEEK ENDING | | | | | | | | | | WEEK ENDING | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Job No. | M | T | W | T | F | S | Total | Gain | Loss | Job No. | M | T | W | T | F | S | Total | Gain | Loss | Job No. | M | T | W | T | F | S | Total | Gain | Loss | Job No. | M | T | W | T | F | S | Total | Gain | Loss |
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| Reg. Time | | | | | | | | | | Reg. Time | | | | | | | | | | Reg. Time | | | | | | | | | | Reg. Time | | | | | | | | | |
| Over Time | | | | | | | | | | Over Time | | | | | | | | | | Over Time | | | | | | | | | | Over Time | | | | | | | | | |

Total Wage Hours ______ @ ______ $ ______ Total Wage Hours ______ @ ______ $ ______ Total Wage Hours ______ @ ______ $ ______ Total Wage Hours ______ @ ______ $ ______

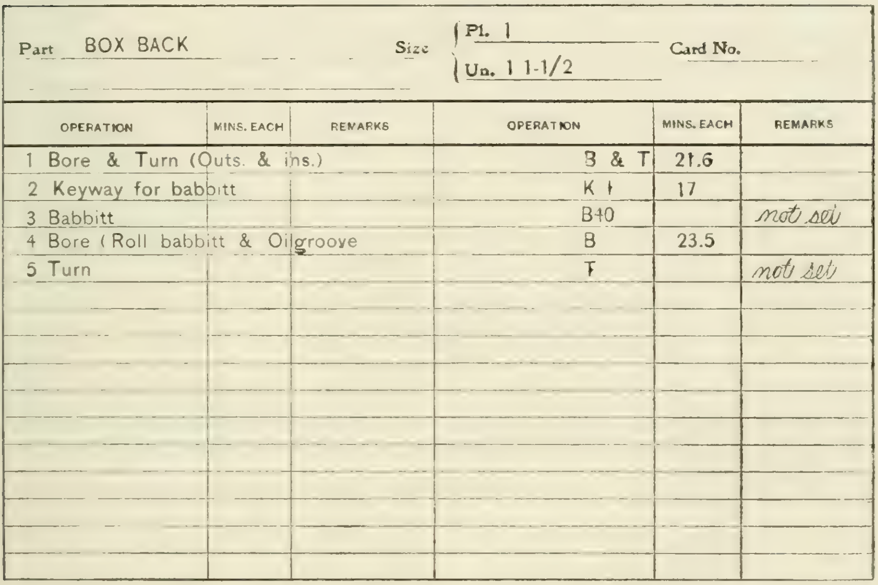
GAIN 4 WEEKS ______ LOSS 4 WEEKS ______ PREMIUM 4 WEEKS ______ HOURS @ $ ______

FIG. 3. MONTHLY TIME SHEET.

The original is 12 by 9½ inches; the left margin is extended and punched for binding. Horizontal rulings are in red for the headings and footings and pale blue for the body. Vertical rules are red, except double rules dividing the weeks, which are green. The color system makes the card very easy to read.

so that they become a record of the workmen's efficiencies. The form of a record card showing operations and time set is shown in Figure 4.

From the pay-roll clerk the time tickets are passed to the cost-posting clerks, who post operation, time, rate, and cost on the individual piece-cost cards, a sample of which is shown in Figure 5. Guide card for this set is shown in Figure 6. In posting on these cards use is made of a code of abbreviations representing the various shop operations. The use of the abbreviations reduces the labor of posting by a large percentage. The use of a letter prefix, such as "B" for boring, "B 1" for first boring, "B 2" for second boring, etc., is suggestive of the name of the operation, and gives less liability to error than the straight numerical system. The company has gone very closely into the details of specifying beyond the shadow of a doubt the exact nature of the operation to be performed. As a result it has been found impracticable to attempt to print all operations on a time ticket and check off the one done, as is the practice in some shops. The list of operations comprises about eight hundred and covers all possible operations including fitting and assembling. It is found in practice that there is as little error in posting an incorrect



Part BOX BACK
Size Pl. 1
Un. 1 1-1/2
Card No.

| OPERATION | MINS. EACH | REMARKS | OPERATION | MINS. EACH | REMARKS |
|---|---|---|---|---|---|
| 1 Bore & Turn (Outs. & ins.) | | | B & T | 21.6 | |
| 2 Keyway for babbitt | | | K 1 | 17 | |
| 3 Babbitt | | | B40 | | not set |
| 4 Bore (Roll babbitt & Oilgroove | | | B | 23.5 | |
| 5 Turn | | | T | | not set |
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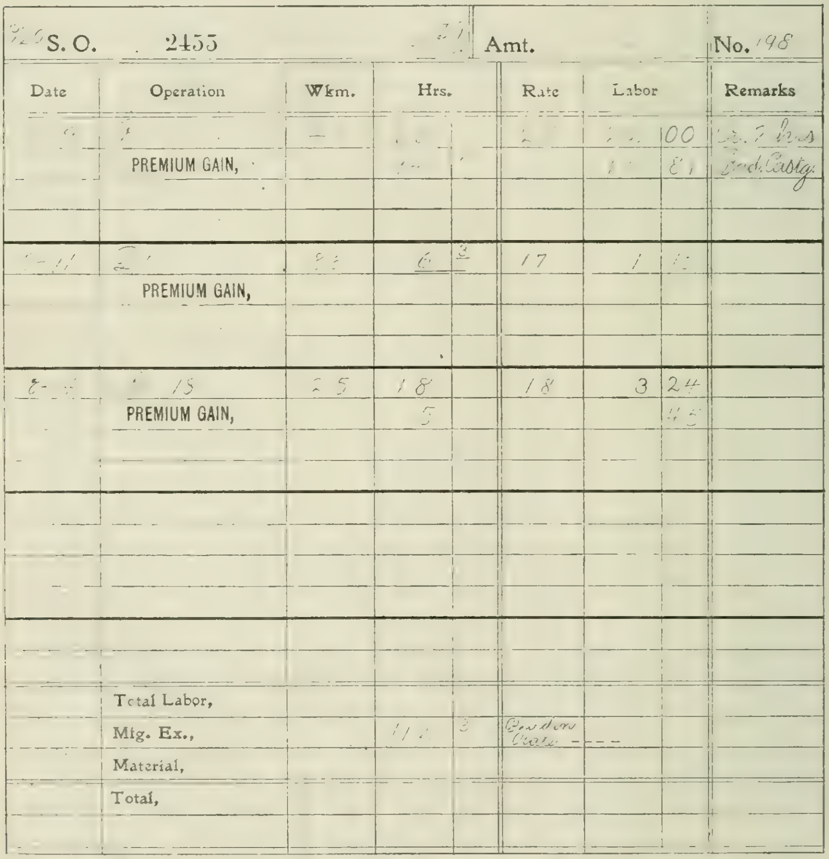
FIG. 4. CARD SHOWING ORDER OF OPERATIONS AND TIME ALLOWANCES.
The original is 6 by 4 inches, thin card, to work in type-writer.

abbreviation as there is in posting any other number, such as order number, number of hours, etc., erroneously. It is true that the cost cards are not intelligible to parties unfamiliar with the code of abbreviations. This is no disadvantage, as consultation of the records by parties unfamiliar with them is inadvisable in any event, and the information desired can be more quickly obtained by some clerk familiar with the card system.

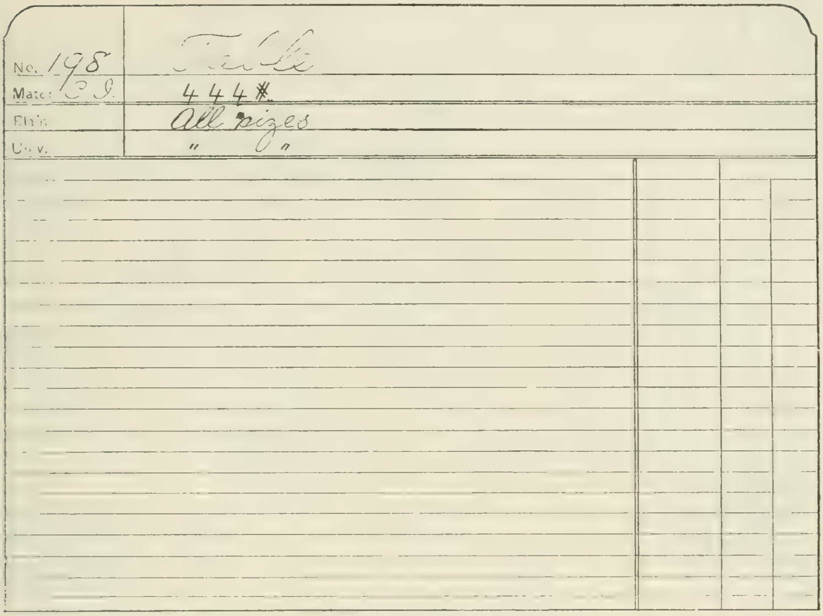
After having been posted on cards, the time tickets are filed in card-index drawers, according to workman's numbers if time has been set, and according to operations if they are to be used as data in setting time. The duplicate tickets are kept in a separate file and returned to the men with the premium earnings.



| S.O. 2455 | | | | | Amt. | | | No. 198 |
|---|---|---|---|---|---|---|---|---|
| Date | Operation | Wkm. | Hrs. | | Rate | Labor | | Remarks |
| [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | 00 | [illegible] hrs |
| | PREMIUM GAIN, | | [illegible] | | | [illegible] | [illegible] | [illegible] Castg. |
| | | | | | | | | |
| | | | | | | | | |
| [illegible] | [illegible] | [illegible] | 6 | 3 | 17 | 1 | [illegible] | |
| | PREMIUM GAIN, | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| [illegible] | 15 | [illegible] | 18 | | 18 | 3 | 24 | |
| | PREMIUM GAIN, | | 5 | | | | 45 | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | Total Labor, | | | | | | | |
| | Mfg. Ex., | | [illegible] | 3 | [illegible] | | | |
| | Material, | | | | | | | |
| | Total, | | | | | | | |
| | | | | | | | | |

FIG. 5. INDIVIDUAL PIECE-COST CARD.

"No. 198" refers to guide-card number. The actual card is about 6 inches high, and carries eight job spaces, instead of four as here shown.



No. 198 Table

Mat'l: C. I. 444#.

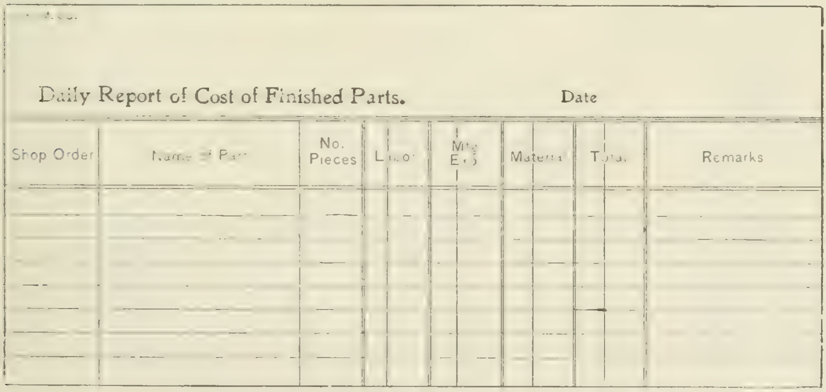
Fin'h All sizes

Unv. " "

FIG. 6. GUIDE CARD FOR INDIVIDUAL PIECE-COST CARDS.

Blue, ruled in red. 6 by 4½ inches.

A daily report of cost of finished parts is submitted to the superintendent on the form shown in Figure 7. On the alternate lines is given the last previous cost of the pieces.

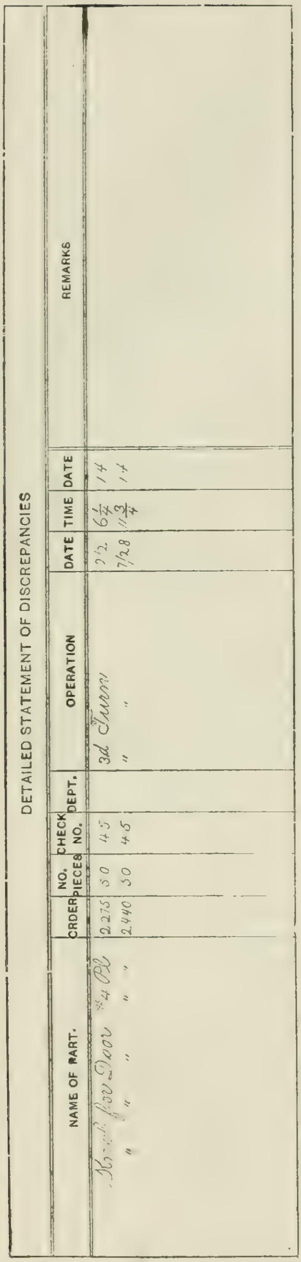


Daily Report of Cost of Finished Parts. Date

| Shop Order | Name of Part | No. Pieces | Labor | Mfg. Exp. | Material | Total | Remarks |
|---|---|---|---|---|---|---|---|

FIG. 7. DAILY REPORT OF COST OF FINISHED PARTS.

Showing headings and ruling. The original is 8½ inches wide and 14 inches high, ruled in red with pale blue horizontal lines.



DETAILED STATEMENT OF DISCREPANCIES

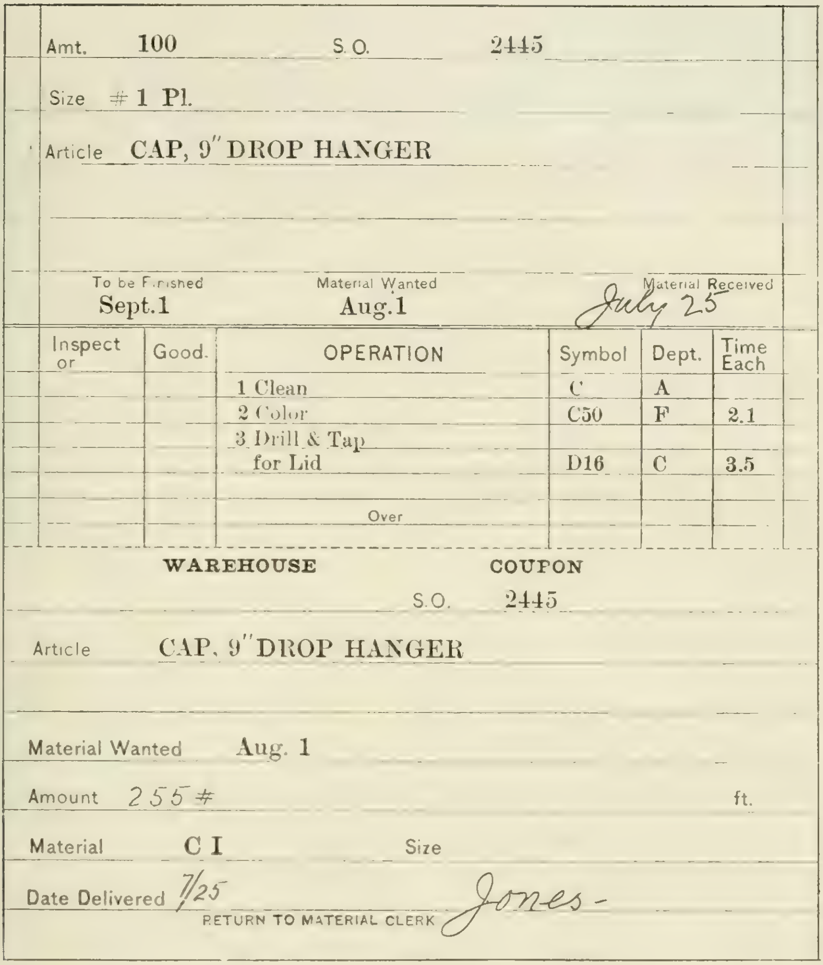
| NAME OF PART. | ORDER | NO. PIECES | CHECK NO. | DEPT. | OPERATION | DATE | TIME | DATE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| Knob for Door #4 Pl | 2275 | 50 | 45 |  | 3d Turn | 2/2 | $6\frac{1}{4}$ | 14 |  |
| " " " " " | 2440 | 50 | 45 |  | " " | 7/28 | $11\frac{3}{4}$ | 14 |  |

FIG. 8. DETAILED STATEMENT OF DISCREPANCIES.

This shows the headings and ruling. The actual form is 14 inches wide by 8½ inches high.

The "Daily Report of Cost of Finished Parts," is acompanied by a "Detailed Statement of Discrepancies in Cost," form for which is shown in Figure 8. The company was fortunate in having complete data extending back a considerable period, covering time taken to do the various operations. The example shown on the form in Figure 8, is but a simple example of a prevalent type, viz., the taking of a longer time to do the work when the men are under the impression that they are fixing the standard time, than it took the same men to do the same work under the same conditions when they had no thought of setting the pace. Costs of entire machines are made up periodically from the last costs of the individual pieces.

In establishing the proper order of operations and determining the time allowance, a clerk was employed to note, on the cards representing the various pieces, the operations reported on these pieces. A certain number of these cards with operations noted on them were taken daily to the various foremen, and the operations checked and entered in proper order as far as possible. These lists were finally verified at foremen's meetings. Should there be a change in the sequence of operations decided on, the retired record card is preserved with notations of reasons for changes. This record will simplify any future discussions of the matter since the reasons for the change are preserved in writing.



Amt. 100 S.O. 2445

Size #1 Pl.

Article CAP, 9" DROP HANGER

To be Finished Sept.1 Material Wanted Aug.1 Material Received July 25

| Inspector | Good. | OPERATION | Symbol | Dept. | Time Each |
|---|---|---|---|---|---|
| | | 1 Clean | C | A | |
| | | 2 Color | C50 | F | 2.1 |
| | | 3 Drill & Tap for Lid | D16 | C | 3.5 |
| | | | | | |
| | | Over | | | |

**WAREHOUSE COUPON**

S.O. 2445

Article CAP, 9" DROP HANGER

Material Wanted Aug. 1

Amount 255# ft.

Material C I Size

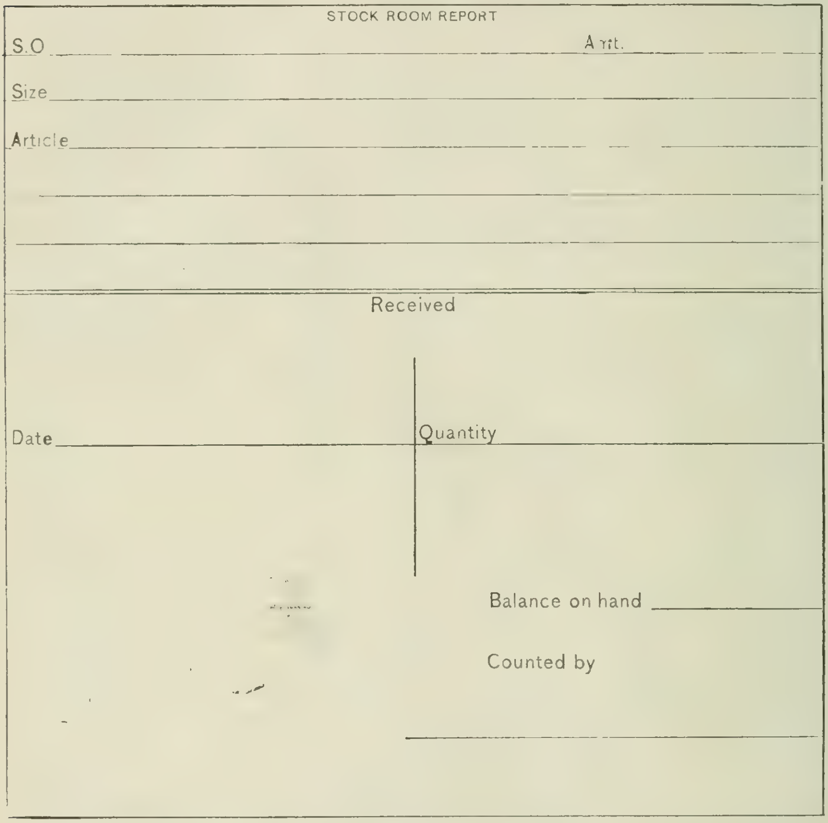
Date Delivered 7/25 Jones-

RETURN TO MATERIAL CLERK

FIG. 9. SHOP-ORDER TRACING TAG.

The original is 8¾ inches high, the extra length being in the spaces for "Operations" in the upper section. The warehouse coupon is detachable at the perforated line as indicated.

In setting time, the time taken to do the work on the particular piece in question was not taken as the only criterion, but the same operation on other similar pieces was also considered. There have been but few cases in which the time as set has been wide of the mark. The average gain in salary by the workmen has been about 10 per cent. per man since the introduction of the premium wage system. At first sight it would appear to an outside observer that a company using the premium wage system, and reserving for itself one-half the profits of the increased speed in the laborer's work, could earn this one-half of the wages as clear profit. It will however be found that the expenses for the clerical work of accurate cost and time keping are nearly as great as the premium payments, and perhaps greater if the premium system covers only a small portion of operations. As the system is extended, however, this will not be the case. The management of the Cincinnati Milling Machine Co. are perfectly satisfied with the results in the greater output, and the reduction of the burden rate, to say nothing of the advantages of having the accurate costs of individual pieces and correct records of individual workmen's efficiencies that the system has brought with it.



STOCK ROOM REPORT

S.O ____ Amt. ____

Size ____

Article ____

Received

Date ____ Quantity ____

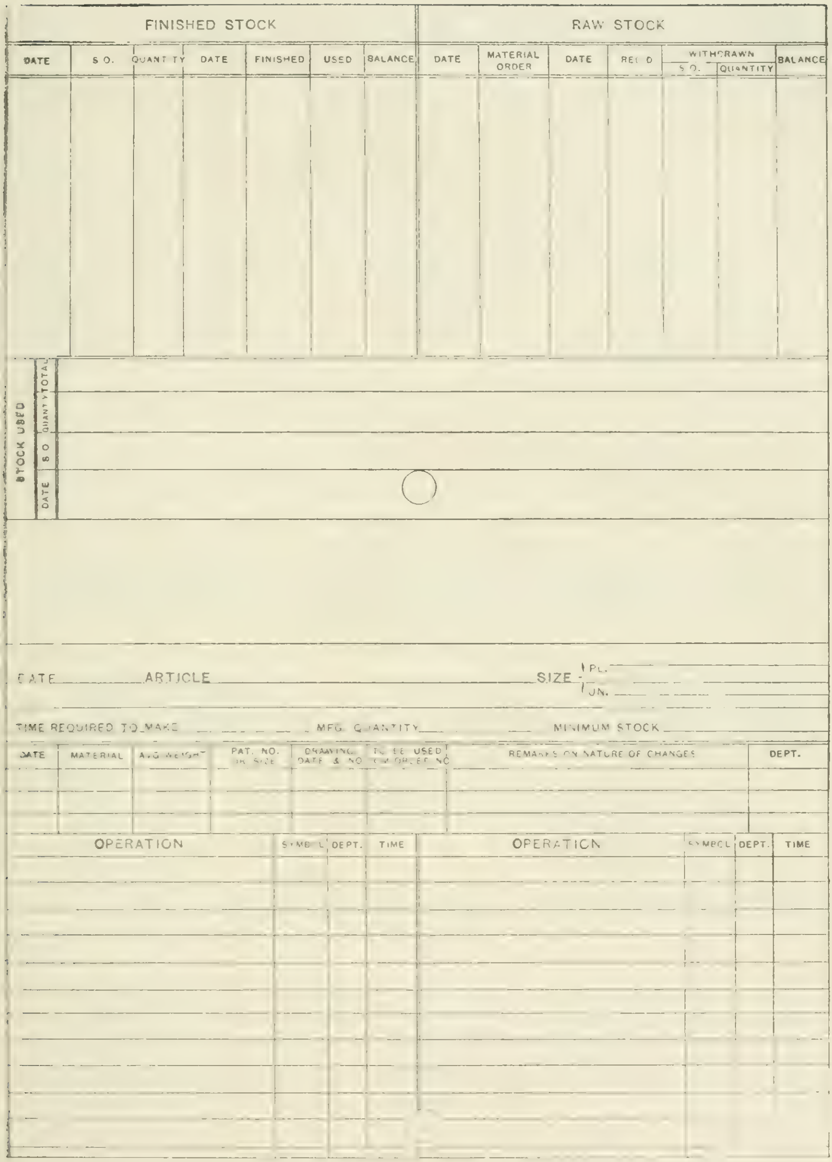
Balance on hand ____

Counted by ____

FIG. 10. STOCK-ROOM REPORT.

The original has more height in the lower part, being 4 by 6 inches.

The shop-order tracing tag is shown in Figure 9. It is printed on



| FINISHED STOCK | | | | | | | RAW STOCK | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | S.O. | QUANTITY | DATE | FINISHED | USED | BALANCE | DATE | MATERIAL ORDER | DATE | REC'D | WITHDRAWN | | BALANCE |
| | | | | | | | | | | | S.O. | QUANTITY | |

| STOCK USED | | |
|---|---|---|
| | TOTAL | |
| | QUANTITY | |
| | S.O. | |
| | DATE | |

DATE ____________ ARTICLE ____________ SIZE { PL. ____________ / UN. ____________

TIME REQUIRED TO MAKE ____________ MFG. QUANTITY ____________ MINIMUM STOCK ____________

| DATE | MATERIAL | AVG. WEIGHT | PAT. NO. OR SIZE | DRAWING DATE & NO. | TO BE USED ON ORDER NO. | REMARKS ON NATURE OF CHANGES | DEPT. |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| OPERATION | SYMBOL | DEPT. | TIME | OPERATION | SYMBOL | DEPT. | TIME |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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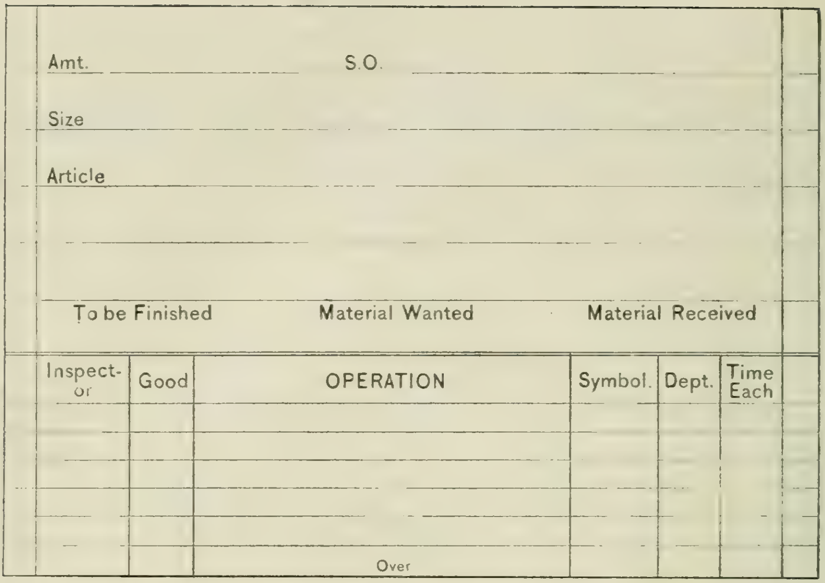
FIG. 11. FRONT AND BACK OF PRODUCTION CLERK'S RECORD CARD.

Original is larger—8 inches wide by 5 inches high. The relative proportions of the various spacings and rulings are approximately preserved in this reduced *fac-simile.*



Amt. ____________ S.O. ____________

Size ____________

Article ____________

____________

To be Finished | Material Wanted | Material Received

|  | Inspect-or | Good | OPERATION | Symbol. | Dept. | Time Each |  |
|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
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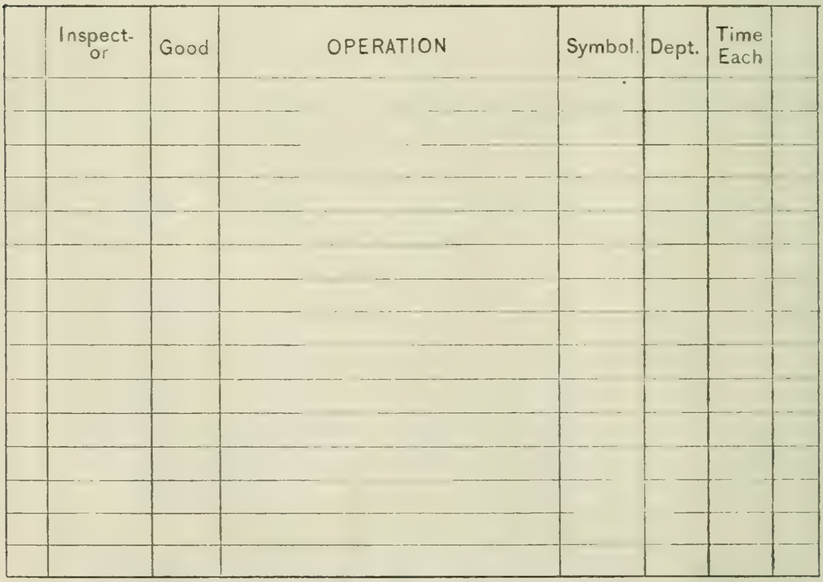
|  |  |  |  |  |  |  |  |
|  |  |  | Over |  |  |  |  |

RED TAG FOR RUSH ORDERS.

This card is a bright rose-pink color, and is held by a clip in a tin frame with turned up edges. It is 4 inches wide by 6 high, having 20 horizontal lines in the lower part instead of 6 as here shown.



|  | Inspect-or | Good | OPERATION | Symbol. | Dept. | Time Each |  |
|---|---|---|---|---|---|---|---|
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BACK OF RED "RUSH-ORDER" CARD; FACE IS SHOWN JUST ABOVE. Original is 6 inches high.

stiff bond paper to permit manifolding on the typewriter. When the raw material is in, the foreman doing first operation on piece receives the tracing tag. When he is ready to start work on it he sends tag with warehouse coupon attached to the stock keeper of the raw-material warehouse, who retains the warehouse tag when he sends the material into the shop, and returns the tag to the shop-order or production clerk. As many manifold copies of the order-tracing tag are made as there are departments to work on the piece, these copies being printed on yellow paper and serving as foremen's notices that the work will be in the shop. These foremen's notices are filed in card-index drawers with chronological guide cards. Each foreman's drawer of notices of work in hand is daily gone over by the tracing clerk.

One manifold copy also goes to the stock room. This copy is shown in Figure 10. When finished parts are all turned in to the stock room this copy is sent to the production clerk with a note of the balance of that part on hand, *by actual count.* Similar notice of balance by actual count is made on the foremen's requisitions for withdrawals, and turned in to the production department. In this way actual count is made daily of from fifty to one hundred items in the stock room. The production clerk's card record from which he issues the order-tracing tags is shown in Figure 11.

The rush-order tracing tag is mounted in a light tin frame (see cut page 588) in order to protect it from dirt and grease, which made the old style of tag (an ordinary shipping tag) illegible in many cases.

The number of men employed in working out the system is as follows:

Time-keepers, two men.

Production department—shop order clerk and assistants—three men.

Stock room, three men.

Cost department, including pay-roll, and establishing of order of operations and setting time, eight men.

It will thus be seen that the total number of men doing work in connection with the system is sixteen.

# EDITORIAL COMMENT

WHILE we have always been justly proud of American progress, and fully appreciative especially of that preeminent genius for doing things economically and well which is characteristic of American engineers, we have never been among those who thought the whole world was finally won, and foreign engineering enterprise laid captive at the feet of the manufacturers of the United States, because we built some bridges in Burmah, sold machine tools in Germany, or furnished a score or two of locomotives to the British railways. It was all good and gratifying, and it opened vistas of possible expansion which we hope and believe American manufacturers will realize and widen, to their enormous advantage. But the very keenness of activity into which Europe—and especially England—was startled by even the relatively small contracts taken in competition by American bidders, showed plainly that the Old World had been napping, and now thoroughly awakened, would not so readily allow a march to be stolen again.

* * *

IT was indeed, as we have said before, a stolen march—stolen while England slept in the fancied security of her one-time primacy as manufacturer to the World ; but this very sleep gave her a reserve upon which we had been meanwhile drawing—a reserve of unutilized possibilities of better machinery and processes, of unrealized economies in shop-practice, of unapplied margin of output capacity in the worker. We have steadily urged our conviction that England, which lives by foreign trade, would spare no effort nor expense to place herself again in the fore, and that the best of everything that goes to manufacturing success—tools, methods, talent—was open to her adoption or her purchase, while the soundest economic system and the most magnificent commercial and marine development were hers already. Indeed, we have pointed out that many of the contracts taken by Americans were secured either because Britain was too busy already to handle them, or because she was actually equipping herself, through them, to meet and underbid America in future.

Time is bringing proof of the truth of our view. When the present enormous home activity lulls and American machinery makers again seek the saving aid of the foreign market, they are likely to find their competitors abroad far better equipped to meet them with the very weapons which formerly won the victories for the United States. Even now there are signs of changed conditions. Two press despatches of the day tell of British success against "keen American competition"—one in bidding for electric tramways for Lorenzo Marques, and one in a contract for locomotives for the Canadian Pacific Railway. In the former case the English firm "offered to do the work quicker than the Germans and at less price than the Americans"; in the latter the Scotch builders got the contract "because they promised quicker delivery of the engines." This is a defeat on our own ground—low cost and prompt delivery.

Nothing is further fromour thought than to suggest that there is in this any discouragement to American manufacturers from entering the foreign field. We are more than ever convinced that open markets abroad are essential to the security and stability of the American machinery trade. But these facts indicate that manufacturing conditions have been very much evened up—that the foreigner has largely cut down that lead of ours in shop economy by which we formerly offset the handicap of our fallacious political economy.

* * *

For fallacious the American high-tariff system will prove, with increasing clearness as, in the inevitable expansion of trade, the foreign market becomes more essential to the American manufacturer. Britain and Germany have already secured so much as they cared to take of our ideas and our methods, and however highly we may rank American mechanical ingenuity, they are not likely ever again to allow us to gain such a lead in our shops as we had but a few years ago. When it becomes clear, as it must, that with equal opportunities for the acquisition of our ideas, the foreigner can actually buy our machines and our raw materials cheaper than we can buy from one another at home, and with the equipment which we have sold him can compete with us to our own disadvantage on neutral ground, we shall wake as a nation to the discovery that our political economy is as obsolete as England's shop economy was when the "American Invasion" startled her to activity and radical reform. It is our earnest conviction that the American manufacturer will be true to his character for discerning quickly the signs of the times, and prompt in putting his obsolete political economy where the British manufacturer has been so courageously putting his obsolete shop economy —on the scrap-heap.

Although the ostensible object of engineering conventions is the presentation of papers upon professional subjects, it is very well understood that by far the most interesting and valuable portion of the proceedings lies in the discussion which is elicited by the formal contributions. As the Arab proverb has it: "The lesson is one, but the talk that follows the lesson is one thousand." This was clearly brought out at the recent convention of the American Society of Mechanical Engineers, when the papers, previously distributed in print, were in many cases read by title only, or the author was called upon to state in the fewest possible words the salient features of his argument, in order that the discussion might be proceeded with at once. It is to be hoped that this will become the standard practice hereafter, and that the whole effort will be the stimulation to active and vigorous discussion of subjects of present importance.

In order that this most desirable result may be accomplished, there are some features which may be mentioned as bearing upon the success of the meetings. In the first place the papers should be in type much earlier than is now the practice. Many members upon rising begin by stating that they have not had time to look over the paper under discussion, having only received it a day or two before. Busy men, whose opinions and discussions are worth having, cannot choose the time when they will examine the papers, and they should have them in their possession far enough ahead of the meeting to be able to give them attention during the opportunities which may come. It would be well also to have the advance copies of the papers printed upon one side of the paper only, thus giving convenient opportunity for the making of memoranda and notes in form available for use during the discussion. This could readily be done at the mere cost of the white paper, since the forms are doubtless arranged to be "backed" in the printing office, and the first run could be left unbacked for the advance copies.

If the authors of papers for presentation and discussion would take a little more care in the systematic presentation of their subjects, it would also aid greatly in the discussions. Some writers prepare their contributions in admirable form, but it must be admitted that in many instances most valuable information is presented in a very slipshod manner. A paper should begin with a brief statement of the points which the author intends to make, arranged in logical sequence, and these points should then be expanded in the body of the paper, and followed by a summing up of the whole, in form for ready reference during the active discussion.

Some contributors have adopted the most excellent plan of appending a bibliography of the subject to the paper, thus advising the members of the original sources of their information, but this is of course applicable only to special cases.

The great point to be kept in mind, by author, publication committee, presiding officer and members, is that it is the discussion which is the thing, and that everything which aids in eliciting a full, intelligent, and varied discussion should be encouraged.

* * *

WE have commented in these pages at various times upon the weird specimens of scientific (?) and other information which appears in the daily papers concerning technical matters, and ventured mildly to suggest that some degree of modern technical knowledge be included among the other accomplishments of certain members of the staff. Those who have observed the kind of reporters who are detailed to attend the professional sessions of scientific societies can readily realize how such grotesque statements get into print as those to which we refer, and indeed it has become matter for surprise when a really intelligent account of an engineering matter is published in the daily papers.

The latest candidate for the freak scrap book is a remarkable account of the new dam and barrage across the Nile, for the control and regulation of the water for irrigation. Accompanying more than two columns text, mostly irrelevant, one sees an elaborate bird's-eye view of the Nile, from the island of Philæ to the Mediterranean, with the dam at Assouan shown in considerable detail, but with the water distinctly flowing up-stream! A calm and extensive mill pond is shown below the great dam, while through the sluices on the upper side appears a strong current, rushing up to the picturesque island, the dam apparently having succeeded in holding back but a portion of the waters of the Mediterranean. The Suez canal appears as a sort of spillway, permitting any excess of water in the Mediterranean to escape without overtopping the dam in the foreground.

* * *

IN the death of Sir W. C. Roberts-Austen the applied science of engineering has lost one of its ablest and most vigorous exponents. Space here forbids extended rehearsal of his many and valued contributions to the union of exact science with practical work, but to the engineer his monument will necessarily be the work of the Alloys Research Committee of the Institution of Mechanical Engineers. That engineers have been taught a vast amount of essential knowledge concerning some of the most important materials with which they must do their work is a consequence of his earnest and busy life, and amongst all his other achievements, this will persist and endure.

# REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

## THE METRIC SYSTEM IN AMERICA.

### ITS MERITS AND DISADVANTAGES FOR USE BY ENGLISH-SPEAKING NATIONS—THE QUESTION OF COMPULSORY ADOPTION.

*American Society of Mechanical Engineers.*

PROBABLY there has been no such animated discussion of the metric system by an engineering body as that which took place during the recent convention of the American Society of Mechanical Engineers in New York, apropos of the paper presented by Mr. Halsey upon the subject.

Mr. Halsey's paper was primarily intended to remove a false impression which had become prevalent concerning action which had been taken by the society at a previous meeting, the advocates of the system having misconstrued a resolution intended to refer generally to the work of its committees into an authoritative expression of opinion by the society favorable to the metric system.

In general Mr. Halsey's argument was based upon an analysis of the extent to which the system is really used in countries which are claimed to have adopted it, and he succeeded in showing what every one but a confirmed metric "crank" is fully prepared to admit, namely, that the old units of weights and measures persist to a marked extent by the side of the new, and in many instances remarkably mixed up with them. It was made altogether clear to the impartial listener that the official "adoption" of the metric system by any country is not successful in insuring a complete transfer of usage from the old to the new, and indeed, as Mr. Halsey put it, the existing systems are "irrevocably tied to the past."

While this is doubtless true, it is also true that the past is past, and is constantly growing further from us, and there is no doubt that old methods and old systems do die out when there is no further use for them. It is also true, however, that the life and persistence of any system depends upon the strength and activity of the people using it. In other words, it is not in the system itself that the vitality lies, but in the commercial and industrial strength and activity of the nations using it. Many of Mr. Halsey's examples are taken from the usage of countries of no commercial or manufacturing consequence, and it is but natural that they should be found using the units of the various nations from which they procure their manufactured articles, mingled with their own old and indeterminate units.

So far as the discussion at the meeting is concerned, it was principally occupied with the question of legislative action to enforce the use of the metric system. The bill which was introduced at the last session of Congress, and which will doubtless be attempted again, is nominally intended to refer only to the work of the various departments of the government, compelling all of them, *except the land office,* to use the metric system in all their work. It is significant that this discussion was thought of sufficient importance to attract the attendance of Director Stratton, of the bureau of standards, and Mr. Southard, the chairman of the house committee of coinage, weights and measures, and that both of the gentlemen accepted the privilege of the floor to advocate the purpose of the bill. Curiously enough, both of them assumed the defensive position altogether, and devoted themselves to explaining that the bill did not mean anything to the engineering profession, and was intended only for the furtherance of the work of the departments of the government. Mr. Southard, indeed, assumed to act as an interpreter of the bill, although the members of the society well understood that if the bill should become law its interpretation would be in the hands of the courts, in spite of any assurances which a member of Congress might previously have given. As a matter of fact the bill does contain the words that after a certain time the metric system "shall become the legal standard of the United States," and it must remain with a higher court than the mere verbal opinion of a member of Congress as to what is meant by those words. Mr. Southard said that the government thought it would be a good plan to try the system upon the government departments first; "trying it on the dog," as he termed it, but when pressed to explain why the operations of the land office had been especially excepted from the action of the bill he explained that so much of the work of that office had been done under the old units that it was thought best to leave them out of the action of the bill. The condition of the land office resembles so closely that of most of the large manufacturing industries of the country, that it is respectfully suggested that that department of the government's work would be the best "dog" which could be found upon which to try the experiment, and one of the strongest arguments which could be brought against the sincerity of the government's position in the matter is this exception in favor of a department in which some trouble would be made for the men concerned. If the bureau of standards and the committee on coinage, weights and measures are really sincere in their desire to use the government as an experimental means of obtaining information, let them do two things to the bill; omit the indeterminate expression "shall become the legal standard of the United States," and include the work of the land office in its action.

So much has been said about the metric system itself, that there is little which can be added here. Nevertheless, it may be permitted to call attention to some points in that connection which are too frequently glossed over. It is well known, and apologetically admitted, that the meter bears no definite relation whatever to the dimensions of the earth, but is merely an arbitrary length of a master standard preserved in Paris; but it is not so generally made public that the true length of this standard is not yet precisely known, but that it is even now the subject of the research of the commission for the verification of the meter, constantly engaged in the pavilion of the International Bureau of Weights and Measures at Breteuil, near Paris. The advocates of the system also keep very quiet about the fact that the kilogramme is not the weight of a cubic decimeter of water, but that it is really only the weight of a piece of platinum of indeterminate density also the present subject of investigation and research. Thus the much-vaunted interchangeability of the units of dimension and weight, so constantly used by metric advocates, is not true, much as they use the statement to the contrary.

The chief argument for the metric system is that it is a decimal system, but there are many very practical men, and many trained mathematicians who deplore the existence of the decimal notation in the present system of numeration, and look upon the enforcement of the decimal metric system as a thing to be opposed as delaying the abolition of decimals by the supercession by a better system.

The only real argument which can be logically advanced for the metric system was that made by Mr. George S. Morison at the meeting above referred to, the importance of securing uniformity throughout the civilised world. No matter what the system is, the important thing is that everybody in all nations shall use it. This is true in a superlative degree, but it is not to be accomplished by legislation. It is not so many years ago that French was the language of commerce over the industrial world, but it has rapidly made way for English. In like manner the system of weights and measures which the English-speaking nations see fit to use will also predominate. In spite of the fact that Germany officially adopted the metric system more than thirty years ago, every German vessel still rates its displacement in British tons, its speed in British knots, and its draught in British feet. This is but the natural result of the predominance of Great Britain in all that relates to shipbuilding and commerce. With the United States and the British Empire joining their work by the bonds of a common language and a common system of weights and measures, the predominance of that language and that system is assured in all parts of the world.

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# MODERN AUTOMOBILE VEHICLES.

## MOTORS, RUNNING GEAR, IGNITION, FUEL, AND GENERAL OPERATIVE DETAILS—BRITISH AND CONTINENTAL PRACTICE.

*Messrs. Lavergne, Longridge, and Forestier.*

THREE notable papers have recently appeared treating of the development of the modern automobile, and the general interest at present existing in the question renders it expedient to review them at this time together. The long paper of Captain C. C. Longridge, presented before the Institution of Mechanical Engineers attracted much attention and discussion, while in France the series of papers upon the status of the automobile in 1902, contributed to the *Revue Générale des Sciences* by M. Gérard Lavergne, and the review of the whole subject of automobile construction by M. G. Forestier, in the *Annales des Ponts et Chaussées,* complete the latest word upon the subject.

Captain Longridge gave his paper the somewhat misleading title of "Oil Motor Cars of 1902," while as a matter of fact he treated almost entirely of vehicles propelled by motors using the light volatile essence, petrol, or gasoline. Some day it is to be hoped that a fully satisfactory motor using heavy oil directly without preliminary vaporisation will become an established fact, but as yet there appears to be nothing of the sort available for motor vehicles. Both Captain Longridge and M. Lavergne agree that there has been little improvement in motors since the early machines of Daimler, except in minor details of construction, and in reduction in weight. In this latter respect some of the French makers have made material progress; thus, the 16 horse power Buchet motor used by Santos-Dumont in his dirigible balloon weighed but 5.8 kilogrammes per horse power, while the Centaure motor of 70 horse power made by Panhard for the Paris-Vienna competition weighed but 4 kilogrammes per horse power. Weights of 7 to 8 kilogrammes per horse power are common.

The question of speed regulation continues to be an important one. Although all the vehicles equipped with internal-combustion motors are provided with clutch gearing permitting several changes in speed for one speed of motor, this is not sufficient for road purposes, and something more must be provided. Various methods are employed for the direct regulation of the speed of the motor. The charge of fuel entering the cylinder may be throttled, or the exhaust may be choked. The latter method is maintained to be the more economical, since the most efficient charge-mixture and volume may be left undisturbed. The ignition may also be delayed, this being an effective, though wasteful method. M. Lavergne calls attention to the fact that the recent powerful four-cylinder motors are so arranged that one or more cylinders may be cut out of action at will, this, in combination with the clutch gear mechanism, giving a range of speed variation which rarely requires any modification in cylinder action to be made. Ultimately it is possible that some form of variable speed gear may be designed which will permit the motor to be operated at full speed and power while the speed of the vehicle is controlled altogether by the gearing. This is especially desirable as permitting the maximum power to be used for a slow speed of the vehicle, a matter sometimes most useful.

While the greater part of all the papers referred to is devoted to vehicles propelled by internal-combustion motors, yet other types receive some consideration. Thus M. Lavergne discusses the latest forms of Serpollet steam vehicles at length, and shows the detailed improvements which have been made. Indeed it might almost be assumed that the Serpollet machine holds a position midway between the gasoline and the steam vehicles. The motor is much more like an internal-combustion engine than a steam engine in design, while the coil boiler, with its instantaneous generation process produces a fluid more like gas than steam. The excellent performances which are on record for the Serpollet machines have given them much greater prominence in the automobile world than other steam-propelled vehicles, steam otherwise being used principally with the light runabouts of American origin.

It would appear that the possibilities of the steam turbine for motor vehicles had not yet received the consideration which they deserve. The high speed at which a turbine of the de Laval type is run, for example, renders it light in weight for the power developed, while the steam economy is materially higher than that of small steam engines of ordinary forms. The entire absence of vibration is a feature to be considered, and altogether it would appear that the turbine, in combination with a suitable form of speed reducing and regulating gear would prove an appropriate form of motor for steam vehicles.

Captain Longridge devotes much attention to the possibility of using water spray in the cylinders of internal combustion motors for cooling purposes, and the experience of Banki with this method for stationary motors makes the suggestion feasible. The general feeling that cast iron is an unsuitable material for cylinders and that steel should be used, renders it desirable to provide some effective method for cooling in place of ribs cast upon the cylinder, and the use of internal water cooling with tool-steel cylinders appears to be a matter for consideration and experiment.

It is most interesting to perceive how the motor vehicle has become one of the most important subjects for discussion among engineers, thus forming at the same time a matter for science and for recreation. Ultimately there is little doubt that the motor-vehicle industry will take its place as one of the great manufacturing occupations of the industrial world, ranking with locomotive and steamship building, since the machine must supersede the animal over the entire world. It is well, therefore, that it has thus early come into the hands of the engineer, and that he will prove equal to its solution no one can doubt.

# THE UTILISATION OF NATURAL RESOURCES.

## AVAILABLE STORES OF MATERIAL IN TIMBER, COAL, OIL, AND PEAT, AND OF POWER IN FALLING WATER.

*Presidential Address—Institution of Civil Engineers.*

It is extremely appropriate that the subject of the address of a president of the Institution whose members are devoted to the "art of directing the great sources of power in Nature for the use and convenience of man" should be a review of the present and future stores of available natural resources. Mr. J. Clarke Hawkshaw, in his presidential address before the Institution of Civil Engineers has done this in a manner both profitable and interesting, and from his address we make some abstracts.

Few people realise the quantity of timber used in engineering work, many believing that the present age of steel has relegated wood to a second place as a material of construction. Mr. Hawkshaw shows that the imports of wood into Great Britain exceed in value her total production of pig iron. For the one purpose of railway sleepers wood is extensively used, it being estimated that there are in use nearly 1,500 million sleepers, of a value of 180 millions sterling.

In many parts of the world wood is extensively used for fuel, and unlike coal, it may be made a fuel which is self perpetuating.

It is true that the great virgin forests of the tropics are not now available for lack of proper transport facilities, but it must not be forgotten that these regions may and doubtless will yet become the dwelling places of civilised and industrial nations, capable and desirous of utilising these stores of Nature's resources.

At the present time, however, the cost of coal, in most countries is the important element in the cost of iron and of power.

Notwithstanding the great advance in mining processes, tending to lessen the cost of production, the price of coal is more likely to rise than fall in years to come. At the same time there are supplies in other parts of the world to be considered.

"Many thousands of million tons still remain of the world's store of coal. China has an enormous supply as yet almost untouched. In one province alone, that of Shan-si, it is said, there is coal equal to our present yearly output for 3,000 years. There is coal to meet the world's requirements for many years to come. Even if this were not so, the world is no longer so dependent on fuel now that we are again calling on falling water to aid us in our work, as it was when our forefathers first tried to apply the forces of Nature to the use of man.

"We cannot estimate the total power which the water falling on the earth's surface would produce in its descent to the sea; but we can form some idea of the limits within which it would lie. Assume a depth of 10 in. of rainfall to flow off each square mile of land surface, the mean height of which may be taken as 2,250 ft. above sea-level. Then water from the whole surface falling through the mean height would give 10,340 million horse-power in perpetuity. Our present yearly output of 225 million tons of coal would only give that amount of horse-power for little over half a day.

"It is estimated that 263,000 horse-power could be supplied by the larger rivers of Norway south of Trondhjem without regulation; by regulation the power would probably be quadrupled.

At one of the falls on the Glommen, where there is 45,000 horse-power available, a power-house is now being erected, from whence the power will be transmitted to Christiana.

Germany, Austria and Switzerland have made larger use of water-power for industrial purposes, and in some cases for working railways.

France uses water-power to the extent of 500,000 horse-power already.

Italy is making use of her waterfalls, transmitting power to a distance of 62 miles on Lake Como for railway and other uses.

It is, however, in the United States that most progress is being made in the electrical transmission of water-power. Forty-three companies, having a total capacity of 132,330 horse-power, transmit power for a total distance of 1,549 miles, on an average 30.3 miles, with a voltage which varies from 10,000 to 50,000. The maximum distance to which power is transmitted is from Colgate to San Francisco, 220 miles, with a loss of 25 per cent."

"Africa, with its four great rivers and notable waterfalls, has a vast amount of water power in store for the future. Notwithstanding the requirements for irrigation, some water should be available for power at Assouan. Above the first cataract are six more, and further south are the Murchison Falls, where the Nile descends 700 feet in from 10 to 15 miles. On the Zambesi there is the Victoria Fall, which will soon be accessible by rail. Its height is 420 feet, more than two and a half times that of Niagara. At Stanley Pool, on the Congo, Stanley estimates the discharge when the river is lowest at 1,436,850 cubic feet a second—more than four times the maximum discharge at Niagara."

Apart from coal and from water power, however, there are other sources of fuel energy.

"The world has yet another supply of fuel in mineral oil, which, being liquid, is one stage in advance towards combustion. It has many obvious advantages as regards cost, economy of space and handling, etc., especially for steamships, as was shown by Sir William White in his address at Dover, in 1899, saving stokehold staff and weight, which, for an equal evaporation, was put, he said, as low as 30 per cent. of the corresponding weight of coal. It is used exclusively on the river fleet of steamers on the Volga, and, to some extent, by the Russian, German and Italian navies. On the South Caspian Railway, 1,600 miles in length, no other fuel is used. In the United States the South Pacific Railway has 300 engines fitted to burn oil, and its use on railways in America is extending. In this country, the Great Eastern was the first railway to burn oil fuel on a large scale, and others of our railways are following the example of the Great Eastern. New sources of oil supply are continually being discovered, but the uncertainty of supply is the difficulty in the way of its being adopted on a larger scale for steamships, for which it affords such obvious advantages.

"There is another reserve of fuel in the world in the form of peat. The most productive area for it is the North of Germany and the adjoining parts of Denmark and Holland. In Friesland there are bogs 1,500 square miles in extent, and Germany has more fuel in peat than in coal. A square mile of bog 10 ft. deep contains peat equal in heating power to over 300,000 tons of coal. Ireland has a million acres of large bogs from 10 ft. to 30 ft. deep. The bog of Allan alone has an area of 372 square miles, with an average depth of 25 ft. In Sweden, where peat is more largely used than in other countries, a Crown peat engineer has been appointed. It is estimated that the bogs would yield an equivalent of 3,000 million tons of coal. In Central Sweden as much as one million tons of peat are prepared annually, mostly for metallurgical purposes. For years it has been used in Martin steel and glass furnaces. In Finland, Russia, and Germany locomotive boilers are fired with it. It is now proposed to use peat fuel for electric power stations in Germany. It has been manufactured for fuel for many years, and much ingenuity has been displayed in devising machines for preparing peat fuel. In Germany peat pulp has been treated like paper pulp, being delivered in thin sheets on rollers to drying cylinders. Briquettes made in this way have not much less heating power than coal."

There has been a disposition of late to assume that we are recklessly wasting the resources of Nature, and that with the burning up of the available coal resources a state of barbarism will once more be upon us. In the face of such a view of natural resources as is given in the address of Mr. Hawkshaw we may feel confident that before any one form of stored energy is exhausted others will be found more convenient and efficient.

Wood may always be cultivated, waterfalls lose none of their life by utilisation, while the heat of the sun and the movements of the sea are as yet not directly touched, so that it is altogether too soon to begin to fear any exhaustion of Nature's stores. What may well be feared is that existing sites of industry and power may be shifted to other parts of the world, but it is altogether possible that a realisation of some such changes might go far to break down the present arbitrary and artificial boundaries of nations.

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# THE TESTING OF INDICATORS.

## METHODS OF DETERMINING THE ERRORS OF INDICATOR SPRINGS AND OF MAKING CORRECTIONS IN THE DIAGRAMS.

*E. Roser—Verein Deutscher Ingenieure.*

SO much reliance has necessarily to be placed upon the accuracy of the diagrams produced by the steam engine indicator that it has come to be recognized that in all determinations of magnitude or importance the instruments used should be carefully calibrated. It is then possible to apply the necessary corrections to the diagrams which may have been taken, or to adjust the instrument so that the principal sources of error may be eliminated.

In a fully illustrated paper in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure,* Herr E. Roser examines the various methods used for calibrating and adjusting the springs of indicators, and as he gives the practice of some well known experts and investigators, his paper possesses a peculiar value for all who are interested in this especial branch of steam engineering.

As is well known, there is generally a certain amount of lag in the movement of an indicator spring, so that if lines are drawn at equal intervals by the pencil on the ascending movement they will not always agree with lines drawn at similar pressure intervals on the descent of the piston. These variations are not always the same for instruments of different construction, besides which the errors due to the influence of heat upon the elasticity of the spring, together with other variations, render it especially important that every indicator should be calibrated before it is used in any important investigation.

Herr Roser has gathered descriptions of the testing apparatus used by such investigators as Professor Slaby, of the Charlottenburg Technical High School, Professor Bach, of the Technical High School at Stuttgart, M. Walther-Meunier, and others connected with the official inspection of steam machinery, and hence his paper possesses a peculiar value for all interested in steam engineering.

Naturally the methods of testing the springs as well as the accuracy of the multiplying lever system which first suggests itself is that of direct weighting, and Herr Roser shows apparatus for this purpose as used by several investigators. The general design of these appliances may readily be understood. The indicator is clamped to a suitable bracket, in the inverted position, and a rod inserted through the steam opening so as to bear upon the piston. By means of a yoke carried on this rod any desired direct weighting may be applied and the corresponding position of the pencil point recorded upon a sheet of paper on the drum. A reversed apparatus serves to test the springs for vacuum. Such devices may be used either to record the deviation from equal movements for uniform loadings, or show the variation in loading required for equal pencil movements.

It is evident that the testing of indicators in this manner does not vary materially from the calibration of any type of spring but in the case of the indicator it is very desirable that all the working conditions of the instrument shall be reproduced. For this reason various devices have been made for testing the springs under the action of steam, in order that the temperature correction may be included.

In testing indicator springs under steam it is not sufficient to reproduce the temperature of the working pressure of the steam in the boiler. It has been demonstrated that the temperature of the interior of the indicator cylinder is always lower than that due to the maximum pressure indicated, this difference varying with the point of cut-off, and with the extent of leakage which is permitted past the indicator piston. Thus, for a pressure of 5 atmospheres, for which the normal temperature is 158°C., the temperature in the indicator is found to be only 96°C., or less than the boiling point, while for a pressure of 15 atmospheres, with a corresponding steam temperature of 200°C., the temperature in the indicator reached but 148°C. In the case of a piston which leaked sufficiently to permit the steam to pass it with comparative freedom the temperature in the cylinder approached more nearly that due to the pressure, while in the case of superheated steam it is found that with steam temperatures between 250° and 350°C., the corresponding indicator temperatures are 150° to 170°C.

It is therefore necessary to provide any accurate testing apparatus with some independent method of determining the true temperature of the spring, instead of assuming it to be the same as that of the steam supplying the pressure. Another method, used by Professor Slaby, in his elaborate indicator testing plant at Charlottenburg, is to provide the pressure by a mercury column and pump, independently of the steam used for warming the instruments, thus providing altogether separate sources of temperature and pressure.

It is generally understood that in nearly all forms of instruments of precision, it is almost impossible to obtain extreme accuracy, while it is altogether possible to determine instrumental errors very precisely, and thus enable the corresponding corrections to be made in the observations. Absolutely correct instruments are not made, but the errors or the variations from extreme accuracy may be determined and the proper corrections so made that the final results may be brought to an approach to the truth known to be within certain limits of probability. It is, however, much easier to make corrections for instrumental errors in a series of recorded and tabulated observations than it is to correct a continuous diagram, such as is drawn by an indicator pencil.

For purposes of power measurement it is generally the area of the diagram which is required, and if the scale of the spring for various portions of its travel is not constant, it is evident that any attempt to measure the area as a whole by the planimeter will not give the true mean effective pressure throughout the stroke.

Various methods may be devised to overcome this difficulty, these being based on the division of the diagram into several portions, in each of which the scale may be assumed to remain constant. Each of these portions is then measured separately, using the corrected value of the scale belonging to each, the sum of the several portions being taken as the corrected area of the whole. By using the corrected values for various portions of the range of the spring movement it is also possible to find points in the curve corresponding to the corrected pressure for determinate points in the stroke, and thus a critical examination of the action of the steam at any point in the cylinder may be made.

When it is considered that the indicator diagram is often used for the measurement of power for engines in which the effect of the steam upon a piston several feet in diameter is referred to the action of an indicator piston of about half-an-inch in diameter it will be seen how essential it is that the limit of error should be made as small as possible. The engineer is working at the short end of a very long lever, and every error in the instrumental work is multiplied many times. Herr Roser's paper will be accepted as an excellent contribution to methods which are rendering the work of the steam engineer as precise as that of the chemist or physicist.

## SUBMARINE TORPEDO BOATS.

### THE DEVELOPMENT OF VESSELS FOR SUBMARINE WARFARE IN EUROPEAN AND AMERICAN NAVIES.

*Society of Naval Architects and Marine Engineers.*

THE success which has attended the trials of the submarine boats "Moccasin" and "Adder," the first of the fleet of the Holland boats now under construction for the United States Navy, lends additional interest to the paper of Mr. Lawrence Spear, recently presented before the Society of Naval Architects and Marine Engineers upon the general subject of submarine torpedo boats.

After a general resumé of the historical side of the subject, Mr. Spear proceeds to consider the present status of the submarine, and considers that three nations only, France, Great Britain, and the United States need be considered as beyond the experimental stage.

France, earliest in the field with "Gymnote" in 1886, now has 44 boats built, building, or provided for; Great Britain has 10, and the United States 7 boats.

The original idea of such boats was that of the pure submarine, constructed with but one form of motive power, this being intended both for surface and for submarine propulsion. The necessarily limited radius of action of any form of power suitable for submarine propulsion led to the design of the so-called "submersible" boats, in which a separate power installation for propulsion on the surface is provided, this power also being available for charging storage batteries for use while submerged. This improvement has resulted in greatly increasing the radius, rendering the boat independent of a base so far as power is concerned, and diminishing the risk of disability.

Concerning the modern French submarines, exact information is naturally not always available, but Mr. Spear has given in the main quite correct ideas as to their general construction. At the same time he is not quite up to date in assuming that the French Marine is committed to the use of steam engines, with kerosene fuel for the principal source of motive power, since it is a matter of exact information that the Minister of Marine is interested in the adaptation of a special form of internal combustion motor, using heavy oil direct in the cylinders, as a source of power for the latest submarines.

Apart from the mechanical details discussed in Mr. Spear's paper, there are some points in recent work which may bear upon the success of the problem which he has not mentioned in detail.

Thus it is altogether possible that the use of sodium peroxide may be found a far from efficient method of purifying the atmosphere of a submerged vessel than the use of flasks of air or of oxygen. The experiments of Desgrez and Balthazard show that the use of tablets of the peroxide, dropped into water as required, will replace the consumed oxygen readily, while the released sodium absorbs the carbonic acid, so that there is little difficulty in maintaining a respirable atmosphere for any reasonable length of time.

Again, the difficulty arising from the liberation of explosive gases by the electric storage batteries may be overcome by the use of batteries of the Edison type, in which the electrolyte is not decomposed, and hence evolves no gas. These features may readily be applied to existing submarines without modification, while the substitution of a motor burning heavy oil directly in the cylinder, instead of the volatile and dangerous gasoline, a question already considered by the Holland people, must surely appeal to the engineer as the true solution of the problem, and it is to be hoped that the United States will not let France get ahead of her in this important particular.

The most important portion of Mr. Spear's paper is that in which he foreshadows the developments of the future, with especial reference to the work in France and in the United States; and from his conclusions we make some abstracts.

"Confining ourselves at present to the submersible type, we note that the French and American designs, though independently worked out, are identical as to general principles and close to each other in the main features of design, the difference in the aims of the designers being taken into account. The distinguishing features as submarines are, first, reserve buoyancy, and second, control in the vertical plane by rudder action only.

"The presence of reserve buoyancy undoubtedly increases the difficulty of securing complete and satisfactory control in the vertical plane, as no matter where located it introduces an upward force which requires balancing, and it may, in addition, introduce a turning moment about the center of gravity which also requires balancing. Its advantages, however, entirely justify its presence, since it not only serves as an instantly available element of safety in an emergency, but also permits the submarine to maintain the awash condition whether underway or not, without change of ballast or direct expenditure of power. In this condition, ready to dive instantly, presenting only the conning tower as a target, and herself commanding a complete view of the horizon, the submarine will do a great part of her work, even in the event of the perfection of observation apparatus for use when submerged. It is safe to conclude then that this feature has been permanently adopted.

"The second characteristic, viz., control in the vertical plane by rudder action only, is also fully justified by tactical and construction reasons. It is obvious that a change in depth can be effected in the least time and by the least expenditure of energy, if the vessel be moved in the direction of least resistance: in other words, if she be steered up and down inclines by altering the angle of her longitudinal axis to the horizon. In order to be effective, the turning moment used must be of considerable magnitude and under the most sensitive control, conditions best met by horizontal rudders, which have also the advantages of simplicity and economy of space, weight and power. Other things being equal the rapidity with which a submarine can rise for observation and dive again is a direct measure of its efficiency, since its chance of escape from observation or projectiles is in inverse proportion to the period of exposure. As pointed out below, a loss in this quality may be justified when balanced by a corresponding gain in the equally important tactical feature of speed, but in no other way; hence it may fairly be concluded that this feature also has come to stay."

Mr. Spear says, very truly, that the general design of a submarine must be limited by the geographical conditions of its use. France naturally desires boats which shall be not only defensive, but also offensive, and has therefore adopted forms of considerable displacement, great length in proportion to beam, double hull, with large tank capacity, together with the use of the steam engine and multiple rudders. We have, however, already observed, that the latest French designs include one of the latest forms of internal-combustion engines, using heavy liquid fuel directly in the cylinders. With France the possible enemy is within easy striking distance, and offers vulnerable points in the form of large ports and arsenals.

"Turning now to the United States, her

location with respect to possible enemies is such that there is no immediate prospect of the development of the large submersible into an offensive weapon, still the extent of her coasts, the number of her harbors, and the rudimentary character of her fixed defenses, renders this type preferable to the pure submarine for defensive purposes. The development of the best all-round boat to meet the conditions is likely here also to lead to some increase in total displacement, which, eventually however, will probably not exceed 200 tons. As compared with the larger offensive submersible, such a vessel would be less seaworthy and would have less surface speed, better manœuvring qualities and greater submerged endurance.

"To sum up it appears that the submarine boats of the near future will naturally divide themselves into four types and two main groups, to conform to the different conditions in the different maritime countries. Group I would be suitable for many of the European countries, and would include the large offensive submersible, self-supporting, with auxiliary bottom working features, and the small defensive submarine for torpedo work only. Group 2, suitable for the United States and similarly situated countries, would include the small offensive ground working submarine or submersible (with auxiliary armament) and the medium sized defensive submersible for torpedo work only. It appears, further, that the submarine qualities of the modern boats are based on sound principles, and that the future development of the four different types within the limiting displacements of each must be along the present lines, and in the direction of improvement in the tactical qualities of speed and practical radius of action. As pointed out above, improvements in these respects are largely dependent upon the general improvement of the power installations, and as compared with the corresponding feature in the battleship, the improvement in the submarine bids fair to be the more rapid."

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## ENGINEERING AND BUSINESS.

### THE RELATION OF ENGINEERING TO THE DEVELOPMENT OF COMMERCE AND THE PRODUCTION OF WEALTH.

*Sir W. H. Preece—Society of Arts.*

THERE is a constantly increasing evidence that engineering is becoming more and more closely related to the science of business; or, more precisely, the relation between engineering and successful business is being more closely appreciated than ever before. This is demonstrated, not only by the interesting address delivered before the Society of Arts, by Sir W. H. Preece on the Science of Business, but also by the comments which that address has caused in the technical and scientific press.

Considering the first business as reducible to a scientific system, Sir W. H. Preece shows how its operation may be reduced to certain definite laws, these being broadly divided into those relating to revenue, and its relation to capital, and to expenditure and its relation to revenue. These may then be subdivided, and discussed from a business standpoint, the whole forming a comprehensive scheme of much interest from a purely commercial standpoint.

From the position of the engineer, however, the more important portion of the address is that which deals with the application of the scientific principles to what may be termed engineering businesses; those selected in the address being the industries of water supply, gas works, railways, and telegraphs, the latter including submarine cables and telephones. These industries are examined by means of graphical diagrams of the type commonly used in studying the action of physical forces, and already coming into use for the representation of financial and other business relations.

Considering these industries as in operation in Great Britain alone, Sir W. H. Preece shows by means of diagrams how the water supply of London has been conducted on sound scientific commercial lines, and hence has proved most successful, from a business point of view. Similar diagrams applied to gas supply show that it has proved profitable when managed according to sound scientific principles.

Curves drawn from the data of British railways indicate, that the business is in an unsatisfactory condition, and also show in some respects wherein the defects lie. While the capital is increasing, and the growth of traffic is satisfactory, the rate of growth of revenue is stationary, and the difference between expenditure and revenue is diminishing. The cause for this is found in the manner in which Parliament legislates for the railway world without the least regard to the science of business or the ordinary requirements of commercial prudence. When to injudicious legislation is added the difficulties with labour unions, as well as the expensive and unremunerative competition, sufficient cause may readily be found for the condition of British railways.

In regard to telegraphs and telephones, Sir W. H. Preece may certainly be considered as speaking with what may be termed "inside information." He shows the government telegraphs to be in a most prosperous condition, indicating steady progress and financial prosperity, and the same is true of the General Post Office. The telephone business, however, is in a state of chaos, and the only remedy to be suggested is for the government to take it over wholly.

In the light of these examples certain deductions may be made as to the distribution of profit, these including the extent to which provision should be made for depreciation, renewals, reserve, and redemption or sinking fund, before any allotment for dividends may properly be made. Sound finance means a proper appreciation of all these elements, and a due and proper allocation of a portion of the annual revenue to meet each requirement.

It is these points that the difference between sound and unsound management lies. In nearly all manufacturing businesses the determination of these relations are matters of engineering as well as finance. The layman can see no sound business sense in scrapping a tool, which to all appearances is in perfect condition, and working as well as when it was bought, neither can he see the necessity for a heavy annual depreciation of a plant in which the greater portion of the capital stock is invested. The engineer, however, knows full well that the seemingly perfect tool cannot possibly compete with the newer automatic machines in use by rival establishments, and he likewise sees that the only real commercial value in the entire plant lies in driving it at top speed to its finish while it is yet in the forefront of efficiency, earning its own full depreciation within its own limited economic operative life.

Sir W. H. Preece well says:

"The value of scrapping is not appreciated in England. In America, when a new process is introduced, which effects considerable economy in production it can be shown by simple calculation that it is wise and commercial to sweep away the old plant and install the new; and this is done. English manufacturers are most tenacious of old machinery. I have seen old Boulton and Watt machinery at work that absorbed annually an excess of coal and oil costing sufficient money to have justified its removal a generation ago. But it is in the increased rate of production that justification for scrapping comes in. The American does not wait until a machine is worn out before condemning it. As soon as he realises the fact that up-to-date machinery will save him in time and labour enough to justify new plant, away goes the old plant, and the value of the new is soon repaid by the greater production. In the majority of cases the 'betterment' of machinery is charged against revenue, but it is easy to justify its charge against capital if the value of the increased production exceeds the sum of the capital invested in the old and the new plant. However, the judicious manufacturer should be fortified with a reserve fund to provide against antiquation and provide for betterment."

In all the interesting points brought out by the address we see the impress which modern engineering methods are making upon business and commerce, and it is a question whether the engineer in many ways has not proved himself to be a better man of business than the old time merchant. An important feature in engineering is that to a great extent the engineer is able to control the things with which he works, instead of merely adapting himself and his work to outside influences.

The old business maxim was that success lay in buying cheap and selling dear.

To this the engineer brings the ability to buy cheap and so handle the purchase that it can be sold dear, thus extending immeasurably the scope of the merchant who had to find his markets instead of making them. The faculties which are demanded to make a successful engineer, are in the highest degree those which are needed in the successful man of business, and the business man who does not know something of the methods by which the world's work is done is at a manifest disadvantage. Indeed this is so far appreciated that many successful men are realising that a technical education is a far better preparation for business than the academic and classical training of the schools and universities, although the student may have no occasion whatever for the direct use of an engineering education. Beyond all doubt the business man of the future must be a man of science, of that applied science of which engineering is the most conspicuous example.

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# THE REGULATION OF ENGINEERING PRACTICE.

## ADVERTISING AND THE SEEKING OF PROFESSIONAL WORK AND OPPORTUNITIES FOR ADVANCEMENT.

*Institution of Electrical Engineers.*

ARTIFICIAL restrictions upon the development of a scientific profession have always had their advocates, these ideas being doubtless a relic of the early times when all learning was confined to the priesthood and to secret organisations, but modern civilisation is rapidly outgrowing such mediaeval notions. Occasionally, however, the old disposition to create an artificial exclusiveness crops out, as in the case of the recent circular issued by the Institution of Electrical Engineers. This document, which has been sent by the Secretary to the clerks of certain municipalities and counties, understood to be in the market for professional work, is of sufficient interest to be given in full.

"As it has come to the knowledge of the Council of this Institution that in several cases consulting engineers have applied for employment and in others local authorities have advertised for consulting engineers, I am instructed by the Council to forward a copy of the code of etiquette in such matters that, in their opinion, ought to govern all those belonging to the Institution.

"I am also instructed to urge upon you the great importance of having electrical work well done at the most moderate outlay; and would point out that by advertising, or by employing those who solicit employment either directly or by agents, local authorities may deprive themselves of the services of electrical engineers of high standing and great experience."

### STANDARD OF PROFESSIONAL ETIQUETTE FOR CONSULTING ELECTRICAL ENGINEERS.

*As approved by the Council of the Institution of Electrical Engineers, July 16th, 1902.*

1.—No consulting engineer should solicit employment as consulting engineer verbally, by letter, by agent paid by commission or otherwise, or by any other means.

2.—No consulting engineer should answer advertisements for consulting engineers.

3.—No consulting engineer should advertise for employment.

4.—No consulting engineer should pay by commission or otherwise anyone who introduces clients.

5.—No consulting engineer should receive trade or other discount, or surreptitious commisions or allowances in connection with any works which he superintends.

6.—A consulting engineer who is also directly or indirectly interested in any contracting or manufacturing business should inform his client in writing what his connection is with such contractor.

There are several things about this announcement which demand serious consideration, although at first glance one might almost think that it had been prepared by the humourous pen of Mr. W. S. Gilbert, or have emanated from the cheerful brain of the late Lewis Carroll. That a consulting engineer shall not receive surreptitious commissions or trade discounts in connection with his work is but common morality, subject to laws which are not the exclusive property of any engineering society; and it is also freely admitted that an engineer should not be secretly connected with a contractor or manufacturer who may become a bidder for the work under his charge, but it really seems unnecessary for the Institution of Electrical Engineers to point out the necessity for the observance of the rules of common honesty to its members. The remainder of the circular, however, cannot be taken as other than a huge joke, not to be seriously considered.

Thus, members are forbidden individually to solicit employment, and yet the Institution itself makes an open bid to local authorities for the employment of its members as a whole, calling attention to the "high standing and great experience" of the electrical engineers composing the Institute, and to the sad fact that by advertising, the undertakers will deprive themselves of the services of this worthy body. Again, a consulting engineer may not place his card in the pages of a printed publication, yet he may hang his sign upon his office door, or even insert it in the directory of the office building in which his rooms are situated.

He may not solicit employment by letter, but if any one should, in consequence of this boldfaced advertising on the part of the Institute, write to him, he is actually permitted to answer such letter even though it may relate to his profession, and may lead to a professional engagement in spite of all precautions.

Really the document has not been drawn up with sufficient regard to the proprieties. It actually does leave loopholes, through which electrical engineers may obtain employment; there is a clause lacking, a clause forbidding any member to permit such a thing as professional work to be mentioned to him at all, but requiring him to accept commissions only under compulsion of bodily injury, making it necessary for him to be sought out by the keen scent of bloodhounds and dragged from his carefully hidden lair and haled to work by force.

There is but one consequence which can follow such an absurd piece of mediaevalism as this circular, the growth of an energetic, competent, efficient body of electrical engineers who will scorn to place themselves under such absurd regulations, and who will, by their activity and ability, place the members of the Institute in such a position that there will be no need for them to trouble themselves about the conduct of each other at all, since they will cease to be consulted professionally by any progressive clients. One cannot help recalling the fine scorn of the words addressed by the patriarch to his associates: "No doubt but ye are the people, and that wisdom will die with you!"

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## GOVERNMENT AND PRIVATE SHIPBUILDING.

### WHY IT TAKES SO LONG A TIME TO BUILD AND EQUIP A NAVAL VESSEL FOR THE UNITED STATES.

*American Society of Naval Architects and Marine Engineers.*

IT is a well-known fact that the time required to build a naval vessel is much greater than that consumed in a private yard in the construction of a vessel of similar size and cost for the merchant service. The causes which produce the delays in government work are many and various, and it was to elicit discusion upon them that the paper presented before the American Society of Naval Architects by Mr. George W. Dickie, of the United Iron Works, of San Francisco, was prepared.

Mr. Dickie, who is undoubtedly extremely well qualified to speak upon the subject, believes that a great portion of the delay in government work is due to the practice of changing the designs in the course of construction. This he thinks might be largely remedied. It may not be possible so to design naval vessels that every detail plan is complete before the work is begun, but the design should be complete in every particular, and the specifications should state distinctly how the actual details are to be carried out. That this is not at present the case is shown by the fact that in a recent specification issued by the Navy Department more than two hundred of the most important items were indicated to be built "as directed," this meaning that detailed instructions would be given out from time to time during the course of the work.

"Before the contract is executed the design should be so complete that all structural materials required could be ordered at once, without having to submit new plans for approval. The latest plans from the Bureau of Construction come nearer meeting this requirement than any we have had hitherto. The location and dimensions of every compartment in the vessel should be determined, and should not be subject to change. The dimensions of every armor plate should be shown, and it should be ascertained beforehand that such dimensions are within the manufacturing capacity of the armor makers. The armament should be all finally settled as to amount and location, and the type of all gun ports not only indicated, but practically worked out. The magazines should be worked out in sufficient detail to demonstrate that they will properly stow the amount of amunition they are specified to carry. All means of handling ammunition should appear on the original design, and in capacity should correspond with the specifications. The arrangement of all machinery should be shown, with all piping and platforms, with a practical plan of getting into and out of machinery compartments. And in all such plans of machinery and boiler compartments the bulkheads should be shown their actual thickness of 12 inches, with deep beams and coamings that reduce the available space so much. This would save much time later on in rearranging machinery that must go into a space that has been reduced by the framing of its walls. Drainage and ventilation should also be fully worked out, as part of the original design. We understand that in future additions to the navy of the United States something of this kind will be attempted at the Navy Department. If this should be successfully carried out, and there is no reason why it should not be, these vessels will be several months further advanced at the date of the contract for their construction than has usually been the case, and many changes that have hitherto been necessary to meet the requirements of the design will be obviated."

Mr. Dickie refers to the common opinion that many of the changes are due to the wishes of the builder, and effectively controverts this view. The builder has nothing to gain and usually something to lose by the modifications which are made upon the work in progress, and he would greatly prefer to have complete plans from the start, as economical of both time and money.

The present system proceeds by the preparation of a specification, in conformity with which the various portions of the design must be made. Instead of following this plan, Mr. Dickie thinks that much time would be saved if the specifications were carefully prepared from a completed design. The present system is graphically described.

"In general this system involves the builder in the making of many working plans many times over before the superintending constructor is satisfied with them. Then they may go to the bureau for final approval; but it does not follow that because these plans have been made and remade over and over again, until the superintending constructor thinks they are right, the bureau will approve them and the work go on. For at the bureau they are subjected to another process of examinations and comparisons with work from other shipyards where similar ships are in course of construction, with a good chance of being sent back for revision, with perhaps copies of plans for similar work that had been approved for a sister ship building elsewhere, and this often sends the poor shipbuilder back to the first plan he submitted to the constructor.

"Where plans have to be submitted to the bureau for approval, and all plans involving any design have to be so submitted, we see no advantage in such plans being labored on sometimes for months by the superintending constructor and his staff of draftsmen, and by them returned over and over again to the builder for changes and corrections, then finally sent to the bureau for a similar process, there ending often in disapproval."

Undoubtedly a portion of the present delay arises from the division of responsibility. There should be only one naval architect responsible for the design of the vessel, outside of her propelling machinery. Now we have three parties trying to do the work: the Bureau of Construction and Repair, the superintending constructor, and the shipbuilder, and much time is lost in trying to harmonize the ideas of these three parties. Since the final decision lies with the Bureau of Construction, the time expended by the other two parties is wasted and their efforts act to retard the completion of the work.

While there is much truth in all of Mr. Dickie's contentions, yet there is something to be said upon the other side. With all possible expedition in the work several years must be required to build a first class battle-ship or cruiser. During that time the progress of the art, both in shipbuilding and in warfare, make such material advances that much which might have been up to date at the commencement of the work is becoming obsolete at its conclusion. It is therefore the part of wisdom to leave details which are not absolutely essential in the early portion of the work to be settled at the time when they must be made.

Again, much of the delay in the construction of ships of war is due to features which are absent in vessels for the merchant marine.

Special materials, such as armor plate and special steels frequently cause delay, while strikes and labor troubles often play important parts in the retardation of the work. When to these is added the fact that the development of naval engineering in the work of other nations must be watched and met, so far as possible, we see that there are many unavoidable reasons for the preparation of details as the work is carried along.

Mr. Dickie is right in many of his points, but it can never be expected that work for the government can be conducted on the same methods as obtain in private contracts, and the best that can be done is to effect a compromise between necesarily conflicting conditions.

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# AERONAUTICAL ENGINEERING.

## RECENT ACCIDENTS WITH DIRIGIBLE BALLOONS CONSIDERED AS STUDIES IN DEFECTIVE DESIGN.

*Col. G. Espitallier, in Le Génie Civil.*

As a natural consequence of the success which attended to efforts of M. Santos-Dumont to win the Deutsch prize numerous attempts to navigate the air in dirigible balloons have followed, unfortunately with fatal results in several instances. In order to utilize the lessons which may be learned from these disasters Col. Espitallier has examined these conditions under which the failures ocurred, and from his paper in a recent issue of *Le Génie Civil* we make some abstracts, with comments.

It is not only in the category of dirigible balloons that the list of accidents is confined, since there have also been disasters in connection with ordinary balloons, but the former demand especial attention because of the effect of constructive details upon the results. Of these events Col. Espitallier examines especially those which befell M. Severo, and M. de Bradsky, showing conclusively the extent to which the violation of fundamental engineering principles could be held responsible for the results.

A so-called dirigible balloon differs from one of the common, or spherical, type in the form of the gas bag and in the provision of motive power operating some sort of a propeller. If, therefore, anything occurs to disable the motive power, a dirigible balloon becomes nothing more than one of the common type but of a different shape. It is therefore important that any one aspiring to experiment in aeronautical work should begin by obtaining experience in ordinary ascensions, in company with those already familiar with the subject, in order that he may not have to contend with the novelty of the situation at the same time with the performance of the novel machinery. In this respect M. Severo was undoubtedly deficient, since he had made but three ascensions in all prior to the one which resulted fatally, and in but one of these had he been in control of the balloon.

The Severo balloon contained several novelties in construction, the most marked of which was the shape of the gas bag. This was cut out underneath, much as if a lobe of an orange were taken out from the rest, except that the bag was spindle-shaped, instead of being spherical. The object of this construction was to permit the axis of the propellers to be placed in the axis of the balloon, and thus avoid the transmission of the propelling force through the suspension members of the car. Two propellers were used, one at each end, the power being transmitted from petroleum motors in the car by means of shafts, provided with universal joints. Instead of a rudder, small propellers, with their axes at right angles to the main direction of motion were used for the purpose of turning the machine in any desired direction.

This machine was a bulky affair, being 30 metres in length, and 13 metres in diameter at the middle, there being two motors, one of 24 horse power, operating the rear propeller, and one of 16 horse power connected with the propeller in front, or a total of 40 horse power. Although the balloon of Santos Dumont carried but 16 horse power, the gas cylinder in that case was but 6 metres in diameter, giving 0.5 horse power per square metre of mid-section, while in the Severo balloon the power was but 0.3 horse power per metre of section.

Two great defects appeared in the Severo machine, one being the impossibility of providing a framework of sufficient rigidity to permit the smooth transmission of the power of the motors in the car to the propeller on the balloon; the other, still more serious, the close proximity of the car to the gas bag. As a consequence of the construction above described, the gas escaping from the relief valve, driven by the action of the propeller, mingled with the air in the space beneath the balloon, and igniting from the motors set fire to the whole machine.

The balloon of de Bradsky was in many respects similar to that of Santos-Dumont, the gas bag being 6.10 metres in diameter and 34 metres in length. In order to avoid the fate of Severo, de Bradsky took great precautions against fire, the car carrying the machinery being placed well below the balloon, and the motor so constructed that no ignition could be made from it. The propeller and the motor were carried upon a framework truss composed of steel tubing, so that all the impelling force of the motor had necessarily to be transmitted to the balloon through the medium of the suspension.

Here the defect in the design appeared, since this suspension consisted almost entirely of steel piano wire, without diagonal bracing, and consequently without lateral or longitudinal stiffness. The result of this imperfect connection between the two essential portions of the machine was the rupture of the wire connections during the violent pitching which occurred in the course of a sudden gust of wind, the car falling to the ground, and causing the death both of de Bradsky and his companion, M. Morin.

Both of these disastrous events bear witness to the necessity for the employment of competent engineering ability in the design of such difficult and delicate work as aeronautical machinery.

In such work, where lightness, strength, and stiffness must be united, and in which the maximum amount of motive power is carried and transmitted within the minimum limits of weight, the highest degree of ability in the disposition and use of materials of engineering is demanded. With these is involved a knowledge of the principles of equilibrium, since the question of balancing enters into the problem to a controlling extent. Under such circumstances it is almost criminal to permit ascensions to be made in machines in which such radical defects exist, and if experiments in aeronautics are to be continued, some sort of general inspection should be required to prevent the needless exposure of human life.

In this connection attention may be called to a plan which has been proposed to develope the possibilities of the aeroplane, which is generally admitted to possess greater scientific possibilities than any form of dirigible balloon. If an aeroplane, constructed upon such scientific lines as the machines of Langley or of Maxim were supported by a dirigible balloon it might be altogether possible to obtain such a degree of experience in its manipulation as to allow the degree of support to be gradually diminished and finally withdrawn altogether. The operation would resemble the use of the inflated belt in swimming instruction, the belt being gradually deflated as the pupil gains proficiency.

In some such experimental way as this the dirigible balloon may add to our stock of knowledge in aeronautical engineering, otherwise there seems to be little use in continuing experiments in which there is so much to lose and so little to gain.

# CAVITATION IN SCREW PROPULSION.

### A STUDY OF THE LAWS GOVERNING THE ACTION OF SCREW PROPELLERS AT HIGH ROTATIVE SPEEDS.

*J. A. Normand—Comptes Rendus.*

WITH the introduction of the steam turbine for marine propulsion, and the consequent increase in the rotative speed of screw propellers, certain phenomena have been observed, indicating a different action from that existing at ordinary speeds. This has been considered under various conditions, the latest contribution to the discussion being a paper presented by the well-known French marine engineer, M. J. A. Normand to the French Academy, and published in a recent issue of *Comptes Rendus*.

M. Normand calls attention to the fact that as long as nine years ago he drew attention to the phenomenon which he then termed the rupture of the cylinder of water acted upon by the propeller, but which has more recently been given the name of cavitation. This action may be described in the following manner:

When water is drawn through a pipe by the suction of any machine, such, for example, as a centrifugal pump, the velocity cannot exceed a certain limit, which depends upon the height of the lift. When the lift is zero the maximum theoretical velocity is that of water flowing into a vacuum under atmospheric pressure, being about 14 metres per second; but this velocity is never actually attained in practice, owing to certain operative losses. If the speed of the pump is increased beyond that necessary to produce this velocity the suction column is broken and the excess energy delivered to the pump is expended in the production of eddies and other forms of internal work.

In a similar manner the water is drawn toward the screw propeller of a ship with a velocity due to the atmospheric pressure augmented by the head of water corresponding to the submersion of the screw beneath the surface of the water. A cylinder of water, equal in diameter to that of the circle of the propeller, is drawn in by the action of the screw, and this cylinder remains continuous and unbroken until the velocity with which it approaches the screw exceeds a certain limit; beyond this speed cavities begin to form and the power is expended in the formation of eddies and whirlpools.

There are two points of difference between the column of water in the suction pipe of a pump and the cylinder drawn in by a screw propeller. In the latter case the water is not enclosed, and the velocity produced by the screw is not equal in all parts of the cylinder. Hence it follows that the velocity at which cavitation is produced in the case of the screw propeller, is much further from the theoretical value than in the case of the pump.

The extent of the movement produced by the action of the propeller upon the water is the measure of the resistance of the vessel. If, therefore, the velocity which forms one of the factors of the action of the screw is so high that cavitation is produced it becomes necessary to increase the other factor; namely, the mass of water under action, and this latter is proportional to the surface of the propeller.

Guided by the above considerations, M. Normand has formulated certain rules governing the relation of the surfaces of the circle of the propeller to the velocity, the principal of these relations being that the propelling surface should be proportional to the product of the resisting surface by the velocity, and he applies these rules to an analysis of existing examples of screw steamships.

The fact that the phenomena of cavitation have remained so long unobserved is doubtless due to the fact that the speeds formerly used were too low to produce noticeable effects of this nature.

Thus. in 1878, Froude stated that the propelling surface might be greatly reduced without producing a material diminution in the efficiency of the propeller. At that time the maximum speed of cruisers was about 18 knots, while to-day it exceeds 24 knots. It was about the same time that Froude made the above remark that testing tanks began to be used, and in view of the information obtained by such experimental means, the effect of velocity upon the accepted laws of propulsion became necessarily modified, especially with respect to the question of similarity. The influence of the depth of submergence of the propeller is now understood to be of importance, as will be perceived when its action upon the head of the water delivered to the screw is considered. All these questions must become of increasing importance in view of the constant tendency toward higher speeds, both of propulsion and of propeller rotation.

The experience of Mr. Parsons, in connection with the application of the steam turbine to the direct operation of screw propellers will be remembered by all who have given attention to the subject of cavitation, and the manner in which he obtained satisfactory results by the deeper submergence of the propellers and the proper portion of surface to velocity, is quite in accordance with the theory advanced by M. Normand.

The comparison of the action of the suction of a screw propeller to that of a pump is interesting in that it may have a bearing upon the design of apparatus for jet propulsion. Although cavitation is commonly supposed to be a special property of high-speed screw propellers, it is evident that the suction entrance of a pump used for jet propulsion must be so proportioned that the flow of water may not be broken, otherwise an action altogether analagous to cavitation will occur, with corresponding loss in efficiency.

There is as yet no good reason to believe that any system of jet propulsion is as efficient as that produced by a properly proportioned screw propeller, and this opinion is confirmed by the researches of M. Normand.

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# OVERLAND SPACE TELEGRAPHY.

## THE CRUISE OF THE CARLO ALBERTO TO CRONSTADT AND TO SPEZIA MAINTAINING COMMUNICATION WITH ENGLAND.

*Report to the Italian Minister of Marine.*

ALTHOUGH the greatest distance over which telegraphic communication by magnetic waves has been held has been over the Atlantic ocean, yet in some respects the record of the trials made during the recent cruises of the Italian war ship Carlo Alberto from England to Russia and to Italy is of greater importance. From the official report of Lieutenant Luigi Solari to Rear Admiral Mirabello and the Italian Minister of Marine, published as a supplement to the *Rivista Marittima,* some interesting information is available concerning this remarkable event.

The report, which is a very complete record of the cruises in the form of a log with comments, includes illustrations of the ship, showing the system of wiring, together with a chart of the routes, giving the location of the points from which communication was held, together with fac-simile records of the messages as received in Morse symbols on the tape of the recording instrument.

The cruises were made during the months of July, August, and September, 1902, starting from the Lizard, Cornwall, and proceeding by way of Denmark and the Baltic to the harbour of Cronstadt, where, in the presence of the Emperor of Russia and the King of Italy, Mr. Marconi exhibited the apparatus, and where messages were received from the station at Poldhu, a distance of 1,700 kilometres.

On the return cruise the Carlo Alberto made a stop at Kiel, where numerous messages were received and recorded, the distance being 1,300 kilometres from the transmit ting station in Cornwall, and communication was maintained continuously thereafter during the return to England. Many of these messages were of especial interest, notably one received by Mr. Marconi from Lord Kelvin when the Carlo Alberto was near the mouth of the Elbe, in the North Sea, about 1,100 kilometres from Poldhu.

The return voyages through the Mediterranean to Spezia repeated the success of the cruise in the Baltic, and the records show that satisfactory communications were had from Gibraltar, Cagliari in Sardinia, and from Spezia, this latter communication being necessarily almost entirely overland, a distance of 1,200 kilometres from Poldhu, with the mass of the Alps between.

Apart from the interesting details of the voyage contained in the report, it is of importance to note that the best results were obtained by the use of Marconi's magnetic detector, instead of the coherer, although both were in use. This device, described in a paper presented before the Royal Society in June, 1902, does away with the necessity of tapping or decohering, and permits a telephone to be used as a receiver as well as the recording Morse instrument, and greatly increases the speed of reception.

The installation at the transmitting station of Poldhu was not materially changed for these experiments, there being four sets of wires supported on four towers of 70 metres in altitude, placed at a distance of 60 metres from each other. The wiring on the Carlo Alberto consisted of a horizontal cable stretched between the tops of the masts, from which a parallel set of seventy wires descended to the instrument room, in which were placed two receivers equipped with coherers and three magnetic detectors.

The experiences which were had in the case of the Atlantic transmissions to the steamship Philadelphia, concerning the greater facility in communication by night than by day, were again noted in these later experiments. Concerning this and other features of the trials the best information can be obtained from the summing up of Lieutenant Solari's report, as follows:

1. No limit has been observed as to the transmission of electric waves over the surface of the globe, provided the energy expended in the transmission is proportional to the distance to be covered.

2. Communication between transmitting and receiving radiotelegraphic stations is not prevented by the interposition of land.

3. The influence of the light of the sun is to diminish the range of radiation of electric waves, rendering it necessary to use a greater amount of energy in transmitting messages by day than by night.

4. The superior efficiency of the magnetic detector over the coherer as a receiving instrument is fully demonstrated, not only with respect to the freedom from tapping, but also because of its greater sensitiveness and convenience.

5. The experiments have demonstrated the entire practicability of the Marconi system, both for commerce and for warfare, without regard to distance.

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# MOULDING MACHINES AND FOUNDRY LABOR.

## THE RELATION OF LABOR UNIONS TO RESTRICTION OF MACHINE OUTPUT IN THE FOUNDRY.

*E. H. Mumford—New England Foundrymen's Association.*

IN an address recently delivered in Boston before the New England Foundrymen's Association, Mr. E. H. Mumford made some very strong points, primarily with regard to the relation of the moulding machine to foundry labor, but applicable broadly to the use of labor saving machinery of all kinds.

In the first place Mr. Mumford showed that he has an abiding faith in the power of right, believing that : "no arbitrary, selfish action either of a corporation or a trades union can ever prevail against the mighty destiny of right—which alone is might."

The moulding machine resembles many other labor-saving devices in that it not only reduces the quantity of labor required to perform a given amount of work, but also enables it to be performed with labor of a lower grade and price. For this reason its use has met with more or less opposition from moulders, who naturally look askance at a device which enables satisfactory work to be done by laborers more rapidly than is possible by skilled men under the old methods.

As Mr. Mumford states, the moulding machine, at its first introduction, was hardly considered worthy of especial attention, but was operated by any one who chose to try it, the output being a variable quantity in the different shops. Now, however, the Iron Moulder's Union has decided to "lay hold of the machine" and to control and regulate its use and output. Mr. Mumford does not in the least object to this, but desires to show that it is altogether possible to find a place for the moulding machine in the foundry which shall benefit and not injure the union moulder. Quoting the president of the union, Mr. Fox, he says that: "the union moulder will never be given the opportunity unless he is willing to do justice to the possibilities of the machine and shows a willingness conscientiously to assist in its development."

The force of this statement depends entirely upon the interpretation which is put upon the words "justice to the possibilities of the machine." In some shops doubtless it would be considered "justice" to the machine to let some heavy casting drop upon it and render it food for the cupola; in others it might be considered permissible to allow it to be operated by skilled moulders only, at a pace no greater than that set by hand moulding; while in other places the machine has been permitted to be operated to its full capacity by labour incapable of higher class work.

Mr. Mumford shows very clearly that there is plenty of work for the skilled moulder outside the scope of the machine, and that it is a wrong to the highly trained man to compel him to do work below his best capabilities. Even if the union is so disposed, it is impossible for it long to compel such a perversion of effort and ability.

"When a foundry owner purchases a machine, which he demonstrates in the shop by actual working is capable of saving labor or saving time and thus can cheapen cost, while dispensing with a kind of skill formerly necessary for the work it does rapidly and well, is there a man anywhere, without or within a trades union, who will pretend that there is any power on earth which can prevent the ultimate success of that machine? If the machine is capable of doing its work with unskilled labor, does any one suppose its operation by skilled men can be forced? Lastly, what arbitrary limitation of what Mr. Fox has called its "best possibilities," will be tolerated by the community at large, which has experienced the benefits of modern machinery, has doubled its life-span by using the loom, the locomotive and the linotype?

"There are two methods by which local unions attempt and often temporarily succeed in limitation of machine economy. The first is by insisting that none but skilled molders should run the machines, with the usual and perfectly natural result that, as the man wants at least as much money for operating the machine as he had before, and doesn't want to work any harder than he did before, the saving effected by the machine is limited to what the molder is willing to concede the machine saves him in actual labor. Now, when a molder who has not been in the habit of using his muscles like an Italian digging a trench, but has for years been doing "first rate," as the foreman would say, putting up and pouring, say, 40 flasks of good work, patterns carefully rapped and drawn, weak corners faithfully swabbed and mended up, these last operations—probably one-half to three-fourths his time—requiring his skill and none of his strength—when this man, who is only half a laborer, is called upon to do what is entirely laborer's work, is it any wonder that he gets tired?

"The second method by which the molder is at the moment seeking to, perhaps only incidentally, limit machine output is by adopting into the union under a special classification the laborers already operating machines, with the result of bringing to bear that unfortunate influence incident to loyalty to a common body of men—a rivalry for popularity by keeping the unit of work as low as possible, while keeping the unit of pay as high as may be. This is a natural tendency of a man or of a body of men who have to sell the product of their hands or their heads for as good a price as they can get for it. In the individual, the effect of this disposition to do the best he can for self varies with the man's capacity for work. It is natural for some men to prefer activity to slowness. Then, too, some men are stronger than others and, in the long run, the active and exceptionally able man rises in output and income above the ranks of his mates.

"If it were possible to raise the standard of the weak by lowering that of the strong, there might be compensating benefits, but it is impossible; a weak man cannot exceed his strength, but it is lamentably easy for the strong man to do less than he is able."

The mistaken idea that the "lump of labor" is of limited size and that the use of machinery will serve only to exhaust it the sooner, is gradually being eliminated from the labor question among the more intelligent portion of the men. Levelling down for the purpose of nursing the job can never persist as an appeal to men whose intelligence is on the upward curve, and it is being more and more clearly perceived that a most important function of the labor-saving machine is to relieve mankind almost altogether from the more brutal and exhausting forms of labor, while at the same time creating more and greater opportunities for work of the higher and more profitable sort for a still greater number of men.

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## PROGRESS OF THE SIMPLON TUNNEL.

### STATUS OF THE WORK OF THE SWISS AND ITALIAN SIDES OF THE LATEST GREAT ALPINE TUNNEL.

*Sixteenth Quarterly Report.*

WE have followed in these columns from time to time the reports made upon the progress of the great work of boring the Alps beneath the Simplon pass, many of the current features of such an undertaking furnishing most instructive information in engineering practice. In a recent issue of the *Schweizerische Bauzeitung* is given the substance of the sixteenth quarterly report, showing the progress which had been made up to October 24, 1902, with some interesting details upon the conduct of the work.

It will be remembered that the original project, upon which work was begun four years ago, involved the boring of a tunnel more than twelve miles (19,731 metres) long through the Alps, enabling the Jura-Simplon railway, running from Geneva up the Rhone valley, to connect with the Italian road from Milan at Iselle, and furnishing an all-rail route between Geneva and Milan, and connecting with the entire railway system of northern Italy; materially shortening the travelling distance between Milan and Calais, besides simplifying communication with western Switzerland. The plan includes a single-track main tunnel, with a smaller parallel tunnel, available from the first for drainage and ventilation, and capable of ultimate enlargement for a second track.

At the time of the completion of the sixteenth quarter, covered by the present report, the mountains had been penetrated to a distance of 7,888 metres on the Swiss side and 5,361 metres on the Italian side, or a total of 13,249 metres, or about 67 per cent. of the entire distance. This includes the extreme penetration, but of this more than 11,000 metres, or about 57 per cent. of the whole has been completed to the full section and lined with masonry.

The present report includes some interesting information concerning the geological constitution of the mountain, the borings continuing to be through gneiss on the Swiss side, the rock containing in most parts both white and black mica, although in some places it is entirely free from mica, being entirely white. In the headings on the Italian side the rock consists mainly of anhydrite, the borings passing through strata of dark limestone situated at angles varying from horizontal to 20 degrees to the southeast. At the extreme end of the borings on the Italian side the rock appears to be a similar gneiss to that met on the Swiss side, although not identical with the fundamental formation of which Monte Leone consists.

The rock temperatures continue to be unusually high on the Swiss side, reaching 44.4°C. (104°F.), while on the Italian side the maximum heat is given as 29°C. (84°F.) These are the actual temperatures of the rock, as determined by thermometers inserted into bore holes, the working temperature being kept within comfortable limits by ventilation and by the flow of water from the subterranean streams.

Still higher temperatures have been found in researches made for the purpose in bore holes of one metre in depth in selected positions free from external cooling influences. Under such conditions rock temperatures as high as 53°C. (127°F.) have been measured.

The flow of water has not materially

changed since the last report. The northern, or Swiss side, is almost absolutely dry, while on the southern side as many as seventeen streams have been tapped, these being of small size, the flow of all making but 18 litres per second (0.63 cubic feet per second). These streams are of minor importance, many of them gradually drying up and being replaced by others during the progress of the work. The great outburst of water, which caused serious trouble in the earlier portion of the work on this side continues to flow in undiminished volume, the discharge being 1118 litres per second, (about 40 cubic feet per second) according to careful measurements made in Auguset, The source of this flow is as yet unknown, no connection with any external supply having been discovered.

The number of men employed upon this great work continues at about three thousand, of which nearly nine hundred are engaged outside of the tunnel proper, being employed upon the power station, transportation work, etc. Only four to five hundred men are engaged in actual work in each end of the tunnel at any one time, the work being continued in successive shifts.

The plan of the work accompanying the report shows very clearly the manner in which the auxiliary tunnel permits the work to be carried on to advantage in the main bore. There are connecting passages giving communication between the two tunnels every 650 feet, and through these the tracks are laid enabling the material to be removed from the forward headings without having to pass the ones behind. In this manner it is possible to keep four gangs of men at work, enlarging and finishing the main tunnel, each gang being served by the auxiliary tunnel connection nearest to it.

The auxiliary tunnel, being driven ahead of the man bore, is always ready for the heavier work beside. The advantage of this mode of conducting the work is evident, since both tunnels, when completed to full size will represent a much smaller amount of excavation than would be required for a double track tunnel of full section.

During the sixteenth quarter there were 59 accidents to workmen on the Swiss side, of which two were serious, and on the Italian side there were 89 slight accidents, and no serious ones.

# REINFORCED CONCRETE MASONRY.

## THE REMARKABLE INCREASE IN RESISTANCE TO COMPRESSION OF CONCRETE PIERS AND COLUMNS.

*M. Considère, in Le Génie Civil.*

BY far the greater portion of the research and experiment which has been given to reinforced-concrete construction has been directed to the investigation of beams and floors, or similar details in which the combination is subjected to flexure and partial tension. While these undoubtedly form most useful applications, of wide value, they by no means indicate the limitations of the principle.

The question of the resistance of reinforced concrete to crushing stresses forms the subject of a series of important papers by the well-known French engineer, M. Considère, published in recent issues of *Le Génie Civil,* and although various phases of the matter are dealt with, we may extract but a few of his conclusions.

Concrete is generally supposed to possess a high degree of resistance to crushing in itself, and nearly all the attempts which have been made to supply it with a metallic reinforcement have had in view the provision of resistance in that portion of the structure subjected to tensile stresses. Thus, in the case of arches, the wire, rods, or other metallic reinforcements are so placed as to resist the tendency to open at the points of usual rupture, the compressive strength of the concrete being left to meet the crushing forces. Again, in floors and beams, the reinforcement of metal is placed below the neutral axis as far as practicable, in order to meet the tension there caused by the deflection under loading.

The usual method of constructing compression members in reinforced concrete has been to insert metal rods parallel to the axis, so that in the case of piers of columns there have been used vertical bars or rods, in some instances old rails having been employed, although it must have been evident that the resistance of the two materials could not in any way be equalised to the compressive stresses under such conditions. The real idea in such structures seemed to have been the provision of some method of tying in the reinforcement of the beams and floors to the metal in the pillars or piers by which they were supported.

M. Considère, however, proceeds differently. Observations of the manner in which piers of simple concrete yield to crushing serve to show the manner in which they can best be reinforced. When such tests are made, it is seen at once that the first evidence of yield appears in a swelling in diameter about the middle of the pillar. When the load is increased this swelling becomes greater and greater until the mass bursts, so to speak, and the upper portion descends upon the lower, crushing the whole into one heap. This action reveals the fact that the weak element in the pillar is its resistance to bursting, showing that the true plact to apply reinforcement is about the circumference. As a consequence pillars have been made with metallic hoops about them, or more simply, a winding of wire has been used, this reinforcement being slightly buried beneath the surface in order to permit the appearance to be unaffected. The result of such reinforcement under test is truly remarkable, and there is little doubt that such a construction will be found of the utmost value both in engineering and architectural work.

Thus it was found that a pillar of simple concrete, after a period of 14 days was capable of resisting a load of but 50 kilogrammes per square centimetre, while a similar pillar reinforced by a winding of wire amounting to 0.035 per cent. of its volume, carried a load of 460 kilogrammes per square centimetre. A pillar of simple concrete, after a period of 100 days, sustained a load of only 170 kilogrammes per square centimetre, while a reinforced pillar carried 740 kilogrammes.

While these results appear remarkable, there is every reason to see why such should be the case. Strictly speaking the pillar does not yield to compression at all, but to the radial tension shown in the tendency to burst under load. This tendency being resisted by the wire wrapping the mass becomes as resistent as solid rock, exactly as is shown by the results of the tests. The case is analogous to the behaviour of rubber under compression. The material is practically incompressible, and when subject to pressure in one direction it increases in the free dimension; a rubber car spring, for instance, swelling in diameter as it is compressed by the weight placed upon it. If such a spring were wound with wire it would become practically solid, and the measure of its resistance would be the tensile strength of the wire with which it was reinforced. The same state of affairs exists with the concrete column, and the action of the reinforcement is altogether similar.

The ease with which this application of reinforced concrete can be made in building and engineering work should cause it to be extensively employed, the economy and excellence of the method being apparent.

## THE DETERMINATION OF WAGES.

### PREMIUM AND BONUS SYSTEMS AND THEIR RELATION TO THE SOLUTION OF THE LABOR PROBLEM.

*American Society of Mechanical Engineers.*

AMONG the papers presented at the recent convention of the American Society of Mechanical Engineers was one by Mr. Frank Richards, entitled "Gift Propositions for Paying Workmen," which is of consequence mainly for the discussion which it elicited.

Mr. Richards, evidently speaking with all the experience of the workman in the shop behind him, objects to any system which has for its object the increase of the workman's output by offering him a portion only of the increased value thus obtained. He calls all such "gift" propositions, and stigmatizes them as such plans as a "sharper would propose to a simpleton." This position assumes that there is some inherently correct day's work which the employer is bound to get and the employe obliged to give, and that if more work is done the man should be fully paid on such a basis. This is really begging the whole question. The truth is that there is no known fair day's work, and no known fair day's wages; if these things were known there would be no trouble whatever, and everything would be lovely. No two workmen can do the same value of work in a given time, and the cost of running a shop for a given time is different in every shop. It is the object of such systems as the premium and bonus plans to discover what a fair day's output for each individual man really is, and to adjust his wages on that basis.

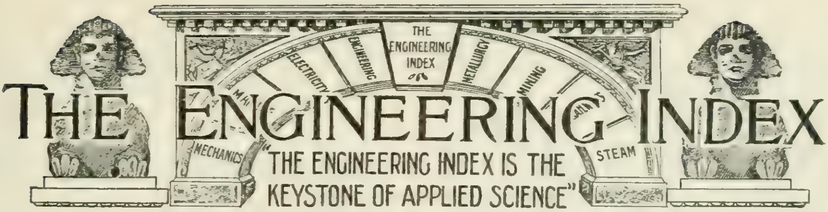
To the mere layman, who does not work in a shop and does not employ workmen the idea occurs: if there is so much difficulty in finding out how much a given amount of time is worth to both parties, why drag in the time question at all? The answer will come at once from both parties to the controversy. Says the workman: "I have to pay my rent by time, I have to feed myself and my family by the day, in short, all my expenses are measured by time!" Says the manufacturer: "All my establishment charges are measured on a time basis; the interest on my capital is measured by time, depreciation, office expenses, motive power, insurance, and everything else is based on time." In short, both parties put up the unanswerable plea: "I need the money."

Leaving aside such special pleadings as based on about as unbusinesslike a foundation as that of the highwayman who holds up the helpless traveller upon a dark night, let us look at the subject for a moment upon a different basis. There is apparently an insuperable difficulty in finding out the payment value of any man's time. A value which suits the payer does not suit the payee, and there is no immediate prospect that this problem will be solved to the satisfaction of both parties. Under these circumstances the best thing to do with the time basis is to drop it altogether. The workman makes something which the employer wants, not for himself, but to pass on to somebody else who wants it still more, and who is willing to pay a piece price for it. In earlier times, when each workman ran his own little place and sold his products direct to the customer, there was no question about day's wages, or premium plans, or any such contrivances; the customer asked how much the thing cost, and the workman charged him all he thought he could get, and the transaction was closed. Why this direct method should not be continued when a third party has injected himself into the business remains to be shown. As a matter of fact, this third party, commonly known as the employer, belongs partly to the side of the workman and partly to that of the customer. He provides the shop, the tools, the capital, and other of the facilities which aid in the production of the work, and he is thus like the workman, interested in getting this expense plus a certain profit back out of the customer. At the same time he acts as the collecting agent, who gathers in the money from the customer, and passes a limited portion of it on to the workman who with himself, makes the article. Each of the two is therefore entitled to a portion of the piece price which the customer pays, and it is over the division of the amount that all the differences arise; the customer usually being altogether helpless.

Apparently the true basis is for each of the parties to act on his own account. The workman might equally well continue to sell his product to the manufacturer, who, while bearing the new name of employer, would then take the identical place of the old time customer, while the employer, adding sufficient to the price to repay him for his outlay plus a profit, again sells to his customer.

Since the facilities furnished by the manufacturer enable the workman to produce things to a better advantage than formerly, he is in a position to charge a lower price than if he had to do the work with his own limited means, and thus a piece price can be determined, just as in the earlier times, being all the workman can possibly get.

The whole obstacle in the way of the adoption of piece work is the apparently insuperable requirement of the employer that the wages of the man, measured by time, should not exceed a certain limited advance on the old day's wages. This he should forget altogether. Let the workman make whatever he can; do not attempt to limit his gains; the thing to be reduced is the piece cost of the article, for it is upon that, and not upon the amount the workman receives that the profits depend.



# THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

*We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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# CIVIL ENGINEERING

### BRIDGES.

**Design.**

Bridges. Review of a book by T. Claxton Fidler, entitled "A Practical Treatise on Bridge Construction: A Text-book on the Design and Construction of Bridges in Iron and Steel. 5200 w. Builder—Nov. 1, 1902. No. 51611 A.

**Double Deck.**

Double Deck Bridge for P. Ft. W. & C. Ry. Crossing the Allegheny River at Pittsburg, Pa. E. A. Amaden. Brief illustrated description with an account of the removal of the old bridge. 1100 w. Pro Engrs' Soc of W Penn—Oct., 1902. No. 51779 D.

**Fire Damage.**

The Fire on the New East River Bridge. An illustrated account of the fire which consumed the temporary framework on the New York tower and also the foot-walks, though the main cables are believed to be only slightly injured. Also brief editorial. 2200 w. Ir Age—Nov. 13, 1902. No. 51673.

The Fire on the New East River Bridge. An illustrated account of the fire, the damage, loss, etc. 2800 w. Eng Rec—Nov. 15, 1902. No. 51719.

The Fire on the New York Tower of the New East River Bridge. An account of this fire with report of damage by Mr. Gus. C. Henning, who personally examined the scene of the fire. Also report of by Mr. Gustav Lindenthal. 2400 w. Eng News—Nov. 13, 1902. No. 51690.

The New East River Bridge Fire. An illustrated account of this disaster, the damage, and the lessons to be learned. 1200 w. Sci Am—Nov. 22, 1902. No. 51775.

Waterproof Wrapping for the Cables of the New East River Bridge, New York. Wilhelm Hildenbrand. Describes methods that have been in use for preserving cables, and have proved successful, and especially the new method adopted for the protection of the cables of the New East River Bridge and the manner of enclosing them in a waterproof covering. 3000 w. Eng News—Nov. 13, 1902. No. 51685.

**Foundations.**

Cooper's Bridge Foundation Specifications. Selected illustrations and abstracts indicating the character of general specifications, prepared by Mr. Theodore Cooper, soon to be published. 3800 w. Eng Rec—Nov. 1, 1902. No. 51583.

**Long Spans.**

Some Interesting Long Span Bridges Now Under Construction. Illustrates and describes the general design and special features of interesting bridges now under construction. 5000 w. Eng News—Nov. 20, 1902. No. 51820.

**Moving Loads.**

Impact and Fatigue in Railway Bridges. J. Graham. Discusses the calculation of the moving load stresses. 1500 w. Engr, Lond—Nov. 14. 1902. No. 51862 A.

**Rhone.**

The New Bridge over the Rhone at Valence (Le Nouveau Pont sur le Rhone à Valence). A description of the new masonry arch bridge, now under construction. There are four segmental arches of 30 metres span. 2000 w. Génie Civil—Oct. 25, 1902. No. 51902 D.

**Steel Arch.**

Steel Arch Electric Railway Bridge Over the Vermillion River at Birmingham, O. Illustrates a high-class construction for interurban electric railway service. 700 w. Eng News—Oct. 30, 1902. No. 51458.

**Viaduct.**

The Des Moines Steel Viaduct. An illustrated description of an important structure on what is known as the Boone cut-off. 2000 w. Engr, Lond—Oct. 24, 1902. No. 51492 A.

**Wreck.**

Fall of a Railway Bridge Near Meadville, Pa. Illustrations and particulars of the accident. 1200 w. Eng News—Oct. 30, 1902. No. 51457.

## CANALS, RIVERS AND HARBORS.

**Breakwater.**

The Break in the Genoa Breakwater (Der Durchbruch des Hafendammes von Genua). E. Bavier. An illustrated account of the injury done to the Genoa breakwater in Nov., 1898, and the manner in which it was repaired. Two articles. 3500 w. Schweiz Bauzeitung—Oct. 25, Nov. 1, 1902. No. 51950 each B.

**Canal Traction.**

Electric Canal Traction in Germany (La Traction Electrique sur Canaux en Allemagne). Marcel Fabre. With especial reference to the installation of trolley tractors on the Teltow Canal between the Spree and the Havel. 2000 w. 1 plate. Génie Civil—Oct. 25, 1902. No. 51903 D.

**Coast Protection.**

The Protection and Improvement of Foreshores by the Utilization of Tidal and Wave Action. Discussion of paper by R. G. Allanson-Winn. Ill. 3500 w. Pro Am Soc of Civil Engrs—Nov., 1902. No. 52014 E.

**Dredging.**

The Cost of Dredging on the Massena Canal. Abstract from a recent paper by John Bogart before the International Nav. Cong. Gives data of cost of dredging in this canal. 1100 w. Eng News—Oct. 30, 1902. No. 51454.

**Erie Canal.**

History of the Erie Canal. Briefly reviews the first construction and improvements made at different times, discussing the proposed enlargement to a 1,000-ton barge capacity, and the cost. 1500 w. Marine Review—Oct. 30, 1902. No. 51469.

**Heysham.**

Progress of Heysham Harbor Works. An illustrated description of the harbor works being constructed for the Midland Railway. 3000 w. Transport—Nov. 14, 1902. No. 51847 A.

**Morris Canal.**

The Inclined Plane of the Morris Canal. Brief illustrated description of the curious inclined plane for raising canal boats over elevations on this canal in New Jersey. 800 w. Sci Am—Nov. 15, 1902. No. 51691.

**Panama.**

The Panama Canal and the Regulation of the Chagres River. Gen. H. L. Abbot. An exhaustive review of the relation of the Chagres river to the Panama canal, giving a complete project for flood control and water supply. 15000 w. Engineering Magazine—Dec., 1902. No. 51991 B.

**Rio Negro.**

The Regulation of a River of Semi-Constant Regime (E Regolarizzazione del Fiume a Regime Semicostante). C. Cipolletti. A hydrographical study of the Rio Negro, Argentina, with map of the river and its drainage basin. 7500 w. Ann d Soc Ing e Arch Ital—No. III, 1902. No. 51971 H.

**River Improvement.**

Full Use of the Rivers at Pittsburg and the Removal of the Obstructions to Such Use. Capt. William L. Sibert. Reviews the present situation at Pittsburg, showing the possibilities of water transportation, and gives a preliminary study with sketches showing a plan for raising bridges in the Allegheny River. 3000 w. Pro Engrs' Soc of W Penn—Oct., 1902. No. 51778 D.

Improvement of the Black Warrior, Warrior and Tombigee Rivers, in Alabama. Continued discussion of R. C. McCalla's paper. 8700 w. Pro Am Soc of Civ Engrs—Nov., 1902. No. 52012 E.

**River Transportation.**

Artificial Limitations of Commerce on Our Rivers. John F. Dravo. Considers the best conditions demanded by river commerce as it now exists, especially the towing system, and bridge construction. 2300 w. Pro Engrs' Soc of W Penn—Oct., 1902. No. 51780 D.

**Tiber.**

The Completion of the Regulation of the Tiber (Sal Compimento della Sistemazione del Tevere). Giovanni Cadolini. An account of the regulation works establishing a navigable channel from Rome to the sea. 6000 w. 1 plate. Ann d Soc Ing e Arch Ital—No. III. 1902. No. 51972 H.

## CONSTRUCTION.

**Building Construction.**

The Hibernia Building, New Orleans. I. Foundations. An illustrated detailed description of special features in a 12-story steel cage building. The present article considers the foundations which are built on very wet soft ground. 2500 w. Eng Rec—Nov. 22, 1902. No. 51844.

**Dams.**

A Plan for Constructing Dams at Great Depth in Water-Bearing Material, with Especial Reference to the Bohio Dam. J. T. Ford. An illustrated description of the method of construction proposed by the writer, with reasons why other proposed plans are not approved. 2000 w. Eng News—Nov. 6, 1902. No. 51593.

**Floors.**

Fire and Load Tests of Concrete Steel Floors. Illustrated descriptions of tests of the White floor system and the American floor system. 1200 w. Eng Rec—Nov. 1, 1902. No. 51587.

The Failure of a Warehouse Floor in Minneapolis, Minn. Sketches of the construction and particulars of the accident which occurred Nov. 7. 2000 w. Eng News—Nov. 20, 1902. No. 51821.

The Johnson System of Floor Construction. Peter B. Wight. An illustrated description of a system which does away with the I beams, only retaining small I beam struts between the columns in opposite directions to the girders. Reports of tests made. 2500 w. Br. Build—Oct., 1902. No. 51428 D.

**Grain Elevators.**

The New Grain Elevators at Genoa (I Nuovi Silos per il Grano a Genova). A general description, with illustrations, of the important new warehouses and elevators at the port of Genoa, Italy. Serial, part I. 2000 w. 1 plate. L'Industria—Nov. 16, 1902. No. 51976 D.

**Pile Drivers.**

Railway Pile Drivers. Abstract of a committee report presented at the Minneapolis meeting of the Assn. of Ry. Supts of Bridges and Buildings. 4400 w. Eng News—Oct. 30,1902. No. 51453.

**Roads.**

Cost of Road Maintenance and Road Maintenance Efficiency. W. Worby Beaumont. Suggests methods of finding values of cost and efficiency for comparison. 1500 w. Engr, Lond—Oct. 24, 1902. No. 51490 A.

Road Building with Convict Labor in the Southern States. J. A. Holmes. From the "Year Book" of the U. S. Dept. of Agriculture. Information concerning the classes of convicts employed, their management, the kinds of roads built, etc. 5000 w. Eng News—Nov. 20, 1902. No. 51824.

The Work of the Massachusetts Highway Commission. W. E. McClintock. Read before the Am. Soc. of Munic. Imp. Reports the work accomplished and the methods of execution. 1500 w. Munic Engng—Nov., 1902. No. 51546 C.

The Work of the New York State Highway Commission. Edward A. Bond. Read before the Am. Soc. of Munic. Imp. Information concerning the work accomplished and work remaining to be done, with remarks on its importance. 1200 w. Munic Engng—Nov., 1902 No. 51545 C.

**Tunnels.**

The North River Tunnels by the Sooysmith Freezing Process. An illustrated outline description of the method proposed. 2800 w. R. R. Gaz—Nov. 21, 1902. No. 51826.

The Simplon Tunnel (Simplon Tunnel). Abstract of the quarterly report showing the progress of the work between June and September, 1902. 1800 w. Schweiz Bauzeitung—Nov. 15, 1902. No. 51953 B.

**Underpinning.**

A Protracted Job of Underpinning. Illustrated description of very difficult work at Exchange Place, New York, where the soil is very fine sand and the building of a steel-cage structure endangered old buildings. 3500 w. Eng Rec—Nov. 1, 1902. No. 51585.

**Vaults.**

The Determination of the Line of Thrust of Barrel Vaults by the Law of Lease Work (Bestimmung der Stützline von Tonnengewölben auf Grundlage des Satzes von de Kleinsten Formänderungsarbeit). J. V. Gerstenbrandt. An exhaustive analytical and graphical analysis acording to the method of Müller-Breslau. 5000 w. 2 plates. Oesterr Wochenschı f d Oeffent Baudienst—Nov. 8, 1902. No. 51978 D.

## MATERIALS.

**Cement.**

Some Notes on Cement Masonry. I. N. Knapp. Read before the Am. Gas Lgt. Assn. Concerning the composition, testing, setting, strength, etc., of hydraulic cement. Also discusses the construction work, the proper way to lay brick in cement mortar, etc. Also discussion. 9500 w. Am Gas Lgt Jour—Nov. 10, 1902. No. 51639.

The Use of Slag in Cement Making. Extracts from advance sheets of a report by Edwin C. Eckel on the Utilization of Iron and Steel Slags, in "Mineral Resources, 1901." 1200 w. Eng Rec—Nov. 1, 1902. No. 51584.

**Cement Works.**

The Portland Cement Works at Djatkowo (Die Portland zement fabrik Djatkowo). Carl Naske. An illustrated description of a works having an output of 500,000 barrels of 170 kilograms per year; situated at Djatkowo, near Briansk, Russia. 1800 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 1, 1902. No. 51915 D.

**Concrete.**

Relative Compressive Strength of Gravel and Broken-Stone Concretes. Sanford E. Thompson. Outlines tests, made in Boston, in 1896, giving interesting comparison between the compressive strength of concrete made with gravel and the strength of similarly proportioned concrete made with broken stone. 2000 w. Am Archt—Nov. 1, 1902. No. 51464.

**Corrosion.**

Corrosion of Steel. A report of experiments made at the Insurance Engineering experiment station, Boston, with comments on the lasting qualities of modern methods of construction. Ill. 5500 w. Ins Engng—Oct., 1902. No. 51537 C.

**Fireproof Material.**

To Render Buildings Fireproof. An illustrated description of how the New York Building Department tests all fire-resisting material. Also editorial. 2800 w. Fire & Water—Nov. 8, 1902. No. 51633.

**Reinforced Concrete.**

Iron Concrete Piers (Ueber Betoneisen Piloten). F. v. Emperger. A description of the reinforced concrete construction of the piers of the new bridge at Brumath, Alsace. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 7, 1902. No. 51923 B.

Recent Experiments with Concrete-Iron Beams (Neue Versuche mit Beton-eisenValken). Dr. Max V. Thullie. An examination of tests recently made in Holland showing the distribution of the stresses in the concrete and in the metal. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 17, 1902. No. 51919 B.

The Hennebique System of Armored Concrete Construction. Leopold Mensch. Reviews early uses of concrete showing its durability, and discusses the value of combinations of concrete and steel, and the things to be guarded against in their use, its applications and value as a building material. Ill. 4800 w. Jour Assn of Engng Socs—Sept., 1902. No. 51534 C.

The Resistance of Reinforced Concrete to Compression (Résistance à la compression du Béton Armé). M. Considère. Discussing recent experiments, showing the extent to which pillars of concrete are strengthened by metallic hoops. Serial. Part I. 2500 w. Génie Civil—Nov. 1, 1902. No. 51905 D.

The Theory of Iron Concrete Construction (Theorie van Cement IJzerconstruction). L. A. Sanders. A review of the theory of Rabut, with data and results of experiments upon reinforced concrete beams. Three articles. 9000 w. De Ingenieur—Oct. 25, Nov. 1, 8, 1902. No. 51960 each D.

**Timber Preserving.**

Timber Preserving Plant of the Alamogordo Lumber Co. Illustrated description of a plant intended particularly for treating ties and bridge timbers by the Wellhouse (zinc-tannin) process. 2500 w. Eng News—Oct. 30, 1902. No. 51255.

## MUNICIPAL.

**Destructors.**

Electricity from Refuse—the Case for the Modern Destructor. W. Francis Goodrich. Abstract of a paper read before the Manchester Soc. of the Inst. of Elec. Engrs. Discusses how far a destructor may be relied upon as a power producer, the conditions needed for success, reporting tests, etc. 3800 w. Elec Engr, Lond —Nov. 14, 1902. No. 51852 A.

**Dust.**

The Dust Problem. Sir James Crichton-Browne. Atmospheric dust, its sources, the injurious effects, and remedies. 13300 w. Jour San Inst—Oct., 1902. No. 51680 E.

**Electric Plants.**

See Electrical Engineering, Generating Stations.

**Pavements.**

The Maintenance of Asphalt Streets. Continued discussion of paper by James N. Hazlehurst. 2000 w. Pro Am Soc of Civ Engrs—Nov., 1902. No. 52015 E.

**Paving Brick.**

The Equipment of a Modern Paving Brick Plant. Willard D. Richardson. A paper given in the *Transactions* of the American Ceramic Society. Plans and description of a plant near Cleveland, Ohio. 2000 w. Eng Rec—Nov. 15, 1902. No. 51721.

**Septic Tanks.**

A Septic Tank at Bedford, Ind. Plan and description of the plant. 1300 w. Eng Rec—Nov. 15, 1902. No. 51722.

New Automatic Regulators for Septic Tanks and Contact Beds. Illustrates and describes two recently patented devices, explaining their operation. 2300 w. Eng Rec—Nov. 8, 1902. No. 51660.

**Sewage.**

Sewage Disposal at Shelby, Ohio. Benjamin H. Flynn. Illustrated description of the purification works which consists of two sludge pits, a settling basin and two intermittent filters of cinder and gravel. 1600 w. Eng News—Nov. 20, 1902. No. 51825.

The Sewerage of Rochester, N. Y. W. J. Stewart. Read before the Am. Soc. of Munic. Imp. Brief illustrated description of the sewers, and their construction, the materials used, etc. 700 w. Munic Engng—Nov., 1902. No. 51542 C.

The Vitality of Sewage Bacteria in Soil and the Antagonism of Soil Bacteria to the Typhoid Bacillus. A review by G. C. Whipple of investigations during the last few years carried on for the Local Government Board of England, as given in a paper by Dr. Sidney Martin. 1600 w. Eng Rec—Nov. 8, 1902. No. 51661.

**Sewers.**

Notes on Designing Chicago Sewers. C. D. Hill. Gives a table and diagram, compiled from the experience of the writer, giving much information of value; reviews the history of the development of Chicago sewers; considers the influence of slope, and presenting conclusions. General discussion follows. 10600 w. Jour W Soc of Engrs—Oct., 1902. No. 51431 D.

**Smoke.**

The Treatment of Smoke. A Sanitary Parallel. W. N. Shaw. Discusses the problem of smoke abatement. 7300 w. Jour San Inst—Oct., 1902. No. 51679 E.

**Storm Flows.**

Storm Flows from City Areas and their Calculation. Ernest Wilder Clarke. Discusses methods of calculating the size of sewer needed to carry off surface water. 4200 w. Eng News—Nov. 6, 1902. No. 51594.

**Street Cleaning.**

Street Cleaning Statistics for Cities Above 3,000 Population in the United States. A. Prescott Folwell. A summary from detailed reports in the Municipal Year Book, with explanatory notes. 1400 w. Eng News—Nov. 20, 1902. No. 51822.

See Mechanical Engineering, Automobiles.

## WATER SUPPLY.

**Artesian Supply.**

The Artesian Water Supply of Long Eaton, England. Notes from a paper by George Hodson, giving a description of the works. 2200 w. Eng Rec—Nov. 8, 1902. No. 51663.

**Consumption.**

The Consumption of Water in Cities and Towns of Massachusetts. Information from the report of the Massachusetts State Board of Health for 1900, designed to cover all available reliable records since the various water-works were installed. 1500 w. Eng News— Nov. 20, 1902. No. 51819.

**Electrical Corrosion.**

See Street and Electric Railways, Stray Currents.

**Filtration.**

The Maignen Preliminary Filters for the Preparation of Water for Sand Filtration. A description of these scrubbers and a discussion of their efficiency and economy condensed from a report made by Messrs. Rudolph Hering and George W. Fuller to the Maignen Filtration Co., based on experiments at Philadelphia.

3300 w. Eng Rec—Nov. 22, 1902. No. 51843.

**Fire Protection.**

An Ideal Water Supply. George F. Chase. Discusses the proper distribution of water, hydrants, pipe, etc. 2500 w. Fire & Water—Nov. 1, 1902. No. 51496.

**Irrigation.**

Irrigation System of the Arkansas Valley Sugar Beet and Irrigation Land Co., Colorado. W. P. Hardesty. An illustrated description of this extensive system, with its history. 6300 w. Eng News—Nov. 13, 1902. No. 51688.

**Meter System.**

Meter System of the Water Department of Baltimore, Md. Robert L. Clemmitt. A description of the testing, inspection, quarterly reading and general management. Ill. 2000 w. Eng News—Oct. 30, 1902. No. 51448.

**New York.**

State Water Supply in New York. George W. Rafter. Read before the Am. Soc. of Munic. Imp. Considers the advisability of reserving a supply for the exclusive use of cities and towns, showing that water could be delivered by gravity, without excessively long conduits, to practically all the cities and towns in the state. 1000 w. Munic Engng—Nov., 1902. No. 51544 C.

**Pollution.**

Inorganic and Organic Sources of Contamination of Water Supplies. E. Starz. An illustrated study of the sources of contamination, their danger, etc., showing the value of a technical, chemical and biological examination of a public water supply. 5000 w. Jour Assn of Engng Socs—Sept., 1902. No. 51535 C.

**Pumping Engines.**

Large Waterworks Pumping Engines in Holland (Groote Pompwerkturgen voor Waterleidingen in Nederland). J. C. Dijxhoorn. Describing the water works pumps at The Hague, Utrecht, Rotterdam, and Amsterdam. 6000 w. 5 plates. De Ingenieur—Nov. 15, 1902. No. 51962 D.

**Reservoirs.**

A New Reservoir at New London, Conn. An illustrated description of a new reservoir nearly completed, which will almost double the water supply. 2300 w. Eng Rec—Nov. 22, 1902. No. 51842.

Report of Aqueduct Commission. The report of the Croton aqueduct commissioners on the subject of the changes in the construction of the new Croton dam and Jerome Park reservoir which had been pronounced defective. Ill. 1200 w. Fire & Water—Nov. 15, 1902. No. 51762.

**Rochester, N. Y.**

Distributing System of the Rochester Water Works. W. N. Radenhurst. Read before the Am. Soc. of Munic. Imp. Describes a double system of supply; from the Genesee River by direct pumpage, and a gravity system from Hemlock Lake. 1000 w. Munic. Engng—Nov., 1902. No. 51541 C.

The Water Supply of Rochester, N. Y. John F. Skinner. Read before the Am. Soc. of Munic. Imp. Brief review of these works which take their supply from Hemlock Lake. 1200 w. Munic Engng—Nov. 1902. No. 51540 C.

**St. Louis Works.**

Improvements of St. Louis Works. Describes a new hydraulic dredge which enables the basins to be cleaned while in regular service, and the plan for filtration. Ill. 1600 w. Fire & Water—Nov. 22, 1902. No. 51832.

**South Wales.**

The Rhondda Water Supply. W. D. Wight. Abstract of a paper read before the S. Wales Inst. of Engrs. Suggests methods of obtaining water for this land-locked valley where an increased supply is greatly needed. 2200 w. Ir & Coal Trds Rev—Sept. 26, 1902. No. 50974 A.

**Water Tower.**

The Water Tower at Grand Rapids, Wis. Illustrated description of a covered steel tank, 154 feet above the ground, supported on 4 columns resting on concrete foundation piers. 1000 w. Eng Rec—Nov. 8, 1902. No. 51662.

## MISCELLANY.

**Address.**

Presidential Address before the Institution of Civil Engineers. John Clarke Hawkshaw. Also editorial. Considers docks, timber, coal, water power, etc. 6000 w. Engng—Nov. 7, 1902. Serial. 1st part. No. 51744 A.

**Argentina.**

Engineering in Argentina. E. L. Corthell. An outline of the physical conditions, the climate, geology, etc., of this country, with an account of important engineering works, and brief review of the history. Ill. 5300 w. Jour W Soc of Engrs—Oct., 1902. No. 51433 D.

**Depreciation.**

Depreciation as Affecting Engineered Structures. Horatio A. Foster. The object of the paper is to set forth some of the usual methods of treating depreciation, and some that are less commonly considered. Also discussion. 8000 w. Pro Engrs Club of Phila—Oct., 1902. No. 51430 D.

# ELECTRICAL ENGINEERING

## COMMUNICATION.

### Cables.

The Completion of the Pacific Cable, and Its Lessons. Calls attention to lessons from the history of this undertaking, and the prospects of improved communication. 2400 w. Elec Rev, Lond—Nov. 7, 1902. No. 51738 A.

The Manufacture of Cables (Ueber Kabel fabrication). Gustav Bergholtz. A review of the development of the manufacture of submarine telegraph cables, with illustrations of modern machinery and methods. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 31, 1902. No. 51921 B.

The Pacific Cable. Illustrates and describes some of the technical features of this recently completed cable. 800 w. Electn, Lond—Nov. 7, 1902. No. 51733 A.

The Military Cable System of the Philippines. Edgar Russel. Describes the conditions under which the work was carried out by the U. S. Signal Corps. Ill. 3800 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52004 D.

The Subterranean Cables to the North. Explains reasons for a continuation of the London and Birmingham line to Manchester and Liverpool, and discusses the difficulties in the replacement of overhead telegraph lines by underground cables. 1400 w. Engr, London—Nov. 14, 1902. No. 51864 A.

Submarine Cable Testing in the Signal Corps, U. S. Army. Townsend Wolcott. An account of the tests made and method of conducting them. 4400 w. Trans. Am. Inst of Elec Engrs—Oct., 1902. No. 52007 D.

### Conduits.

Scope, Extent and Construction of the Underground Conduits of the Illinois Telephone and Telegraph Co. in Chicago. George W. Jackson. An illustrated detailed description of the construction work in building conduits to accommodate 100,000 subscribers. Discussion follows. 4800 w. Jour W Soc of Engrs—Oct., 1902. No. 51434 D.

### Electrograph.

The Improved Electrograph—A Fac-Simile Telegraph. An account of the improvements made in the machine invented by Herbert R. Palmer and Thomas Mills. Ill. 1800 w. Sci Am—Nov. 15, 1902. No. 51693.

### Fire Alarms.

Progress in Fire Alarm Telegraphy. Joseph W. Stover. Extracts from a paper read before the International Assn. of Fire Engrs. Reviews the history and development of this system. 3300 w. Ins Engng—Oct., 1902. No. 51538 C.

### Ship Telegraph.

The Electric Automatic Whistle Operator and Telegraph. Illustrates and describes apparatus designed as an adjunct to the ordinary hand pull for opening the valve in the whistle pipe. 1500 w. Marine Engng—Nov., 1902. No. 51651 C.

### Signal Corps.

Electricity in the Signal Corps. Samuel Reber. Describes the work of the signal corps, illustrating apparatus used in both field and fortress work. 4000 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52009 D.

### Space Telegraphy.

A Supplement to Lieut. Solari's Report on "The Radio-Telegraphic Expedition of H. I. M. S. "Carlo Alberto." Nevil Maskelyne. An account of the interference at Porthcurnow at the time of these experiments, with details of interest, and a query as to the possibility of securing privacy. 2400 w. Elect'n, Lond—Nov. 7, 1902. No. 51734 A.

Popp-Branly Aerial Telegraphy Systems. Information concerning a project in Paris to establish a subscribers system covering the city to give the important news of the day. Ill. 1400 w. Sci Am—Nov. 22, 1902. No. 51774.

Radio-Telegraphy (Radio-Telegrafia). Luigi Solari. The official report of the voyages of the Carlo Alberto to Cronstadt and to Spezia, with logs showing the maintenance of wireless communication with the Poldhu Station, and details of the vessel's equipment. 10000 w. 10 plates. Rivista Marittima—Oct., 1902. Supplement. No. 51969 H.

Some Recent Wireless Telegraphy Patents. Illustrated descriptions of inventions patented by Prof. J. A. Fleming and Marconi's Wireless Telegraph Co. 2500 w. Elect'n, Lond—Nov. 14, 1902. Serial, 1st part. No. 51859 A.

The Radio-Telegraphic Expedition of H. I. M. S. "Carlo Alberto." Lieut. Luigi Solari. Gives a map of the course taken, a description of the installation on the vessel, and an account of the experiments, with other information of interest. Ill. 5200 w. Elect'n, Lond—Oct. 24, 1902. No. 51481 A.

The Wireless Telegraph Station at the Hook of Holland (Het Draadlooze Telegraafstation aan den Hoek van Holland). L. Bleekrode. A description of the Ducretet apparatus operating between the Hook of Holland and the lightship Maas, 15 kilometers out. 2000 w. De Ingenieur —Nov. 1, 1902. No. 51961 D.

Wireless Telegraphy—United States Navy. A. M. Beecher. Explains how electric waves are produced, and gives a brief description of the apparatus employed in wireless telegraphy by different inventions. Also reviews what has been accomplished in this field and what is expected in regard to naval vessels. 3000 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52002 D.

**Telegraphy.**

The Rowland Writing Telegraph. Day Allen Willey. An illustrated description of the apparatus and its operation, with editorial. 3300 w. Elec Rev, N Y—Nov. 15, 1902. No. 51712.

The Use and Advantages of the Alternating Current for Land Telegraphy. Edwin F. Northrup. Describes and discusses the fundamental electrical principles involved in applying the alternating current to transmitting telegraphic signals, and in maintaining synchronous motion over long telegraph lines. 4000 w. Elec Wld & Engr— Nov. 8, 1902. Serial. 1st part. No. 51654.

**Telephony.**

Profitable Telephone Rates. Fred De Land. Discusses the charges of the "Independents" as compared with the experience of the Bell company. Thinks the rates of the former too low to maintain a margin of profit as the business increases. 3800 w. Telephony—Nov., 1902. No. 51504.

The Automatic Telephone and Switchboard. A. E. Kieth and J. F. Crook. Illustrated description of the apparatus with which the immense exchange of the Illinois Telephone and Telegraph Company is to be equipped, stating its advantages. 2700 w. Jour W Soc of Engrs—Oct., 1902. No. 51435 D.

Wireless Telephony. From the *Elektrotechnische Zeitschrift.* A description of the experiments which Herr Ernst Ruhmer made last summer. Ill. 1900 w. Elect'n, Lond—Nov. 7, 1902. No. 51732 A.

## DISTRIBUTION.

**Converter.**

Rotary Converter Set of 150 Horse Power (Drehstrom-Gleichstrom Umformer Gruppe von 150 P. S.) An illustrated description of a rotary converter built by Rieter of Winterthur for the palace at Madrid. A single induction motor drives two continuous-curved generators. 1500 w. Schweiz Bauzeitung—Nov. 8, 1902. No. 51951 B.

**Standard Voltage.**

The Reasons for the Change of the Navy Standard Voltage from 80 to 125. W. V. N. Powelson. Reviews briefly the history of the voltages used by the navy, and discusses the considerations which led to the recent adoption of 125 volts as the standard for all new installations on board ships. 6000 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52005 D.

**Switchboards.**

Modern Switchboard Practice. H. P. Davis. Illustrates and describes types and systems, discussing their limitations and faults, their operation, protection, etc. 9000 w. St Ry Jour—Nov. 1, 1902. No. 51576 D.

**Transformers.**

Single Phase Constant Potential Transformers. George T. Hanchett. An explanation of the law of turns and voltages, considering a concrete case. 2500 w. Cent Sta—Nov, 1902. No. 51676.

The Design of Alternating Current Transformers. Harold B. Smith. Information and data to serve as a guide to those not entirely familiar with recent practice in transformer designs. 3700 w. Jour Worcester Poly Inst—Nov., 1902. Serial. 1st part. No. 51770 C.

See also Electrical Engineering, Generating Stations.

## ELECTRO-CHEMISTRY.

**Accumulators.**

The Max Accumulator (Der Akkumulator Max). J. J. Heilmann. The active material is supported on wires of lead and antimony. 1500 w. Elektrochem Zeitschr—Nov., 1902. No. 51941 G.

The Thallium Storage Cell. A. L. Marsh. Describes this cell and compares it with the lead type, noting the points of difference. 2500 w. Elec-Chem Ind—Nov., 1902. No. 51772.

**Alkali Industry.**

The Present Position of the Electrolytic Alkali Industry. John B. C. Kershaw. The present article gives details of plants in the United Kingdom and in Germany. Ill. 1200 w. Elect'n, Lond—Nov. 14, 1902. Serial. 1st part. No. 51858 A.

**Cleveland, O.**

Cleveland as a Center in Electrochemical Development. Cecil L. Saunders. Reviews the industries in this field which had their beginnings in this city, and those that grew out of them. 2300 w. Elec Wld & Engr—Nov. 15, 1902. No. 51716.

**Electric Furnace.**

See Mining and Metallurgy, Iron and Steel.

**Electrolysis.**

The Electrolysis of Fused Caustic Soda and Potash (Die Elektrolyse von Geschmolzenem Aetznatron und Aetzkali). M. le Blanc and J. Brode. Data and results of experimental work in the laboratory of the Technical High School at Karlsruhe. 2500 w. Zeitschr f Elektrochemie—Oct. 23, 1902. No. 51938 G.

**Galvanizing.**

The Inspection of Galvanized Iron Articles (Ueber die Beurteilung Verzinkter Eisenwaren). Carl Richter. A comparison of the results of electro-galvanizing with the hot dipping process of zincing, describing methods of test. Serial. Part I. 1800 w. Elektrochem Zeitschr—Nov., 1902. No. 51940 G.

**Glass Making.**

Electricity in Glass Manufacture. Reviews an article by Dr. Bermbach, published in the *Elektrochemisch Zeitschrift*, discussing the theoretical and practical aspects of the problem, and giving details of the Becker furnace used in experiments in the electrical manufacture of glass made at Cologne. Ill. 2000 w. Sci Am Sup—Nov. 1, 1902. No. 51446.

**Hypochlorite.**

The Manufacture of Hypochlorite of Soda. Edward Walker. Describes a cell designed by G. J. Atkins of London for electrolyzing solutions of common salt, manufacturing hypochlorite of soda, which is used for bleaching. 600 w. Eng & Min Jour—Nov. 22, 1902. No. 51841.

**Ozone.**

The Purification of the Atmosphere by Ozone. Ernest T. Williams. Describes the apparatus of J. Harris for purifying the vitiated atmosphere of crowded rooms and buildings and for the sterilization of water, etc., by the use of ozone. Ill. 700 w. Elec Rev, Lond—Nov. 7, 1902. No. 51730 A.

**Sault Sainte Marie.**

Electrochemistry at Sault Sainte Marie. Joseph W. Richards. Describes the general situation, its facilities for manufacturing and its possibilities in the electrochemical line. Also gives a description of the Rhodin process of manufacturing caustic alkali and bleaching powder, which is installed here. Ill. 3000 w. Elec-Chem Ind—Nov., 1902. No. 51771 C.

**Terminology.**

Terminology of Primary and Storage Battery Electrodes. A. L. Marsh. Calls attention to the confusion existing on the subject of the polarity of voltaic battery electrodes, and the need of revising the terminology. 2800 w. Elec Wld & Engr—Nov. 15, 1902. No. 51715.

## ELECTRO-PHYSICS.

**Cathodes.**

Distribution of Current at the Surface of Cathodes in Vacuum Tubes. A. Wehnelt. An account of investigations, with illustrations, translated from *Ann. der Physik.* 4800 w. Sci Am Sup—Nov. 8, 1902. No. 51597.

**Electric Sparks.**

Influence of Electrification on the Electric Spark. Ernst Lecher. From the *Annalen der Physik.* An account of experimental investigations which make it appear certain that the electrification of a spark-gap has a decided influence upon the luminous phenomena. 3000 w. Elect'n, Lond—Nov. 7, 1902. No. 51735 A.

**Electric Waves.**

On the Reflection of Electric Waves at the Free End of a Parallel Wire System. Henry A. Bumstead. Explains phenomenon observed and its cause. 1500 w. Am Jour of Sci—Nov., 1902. No. 51536 D.

**Insulating.**

The Application of Insulating Varnish. Arthur B. Weeks. Gives ideas and suggestions from an extended experience. Ill. 1500 w. Steam Engng—Nov. 10, 1902. No. 51643.

**Radiography.**

The Velocity of Propagation of X Rays (Sur la Vitesse de Propagation des Rayons X). R. Blondlot. Recording experiments similar to those used for determining the velocity of light. 2000 w. Comptes Rendus—Oct. 27, 1902. No. 51943 D.

The Equality of the Velocity of X Rays with that of Light (Sur l'Egalité de la Vitesse de Propagation des Rayons X et de la Vitesse de la Lumière dans l'Aair). R. Blondlot. A record of further experiments, showing the velocity of X rays to be the same as of Hertzian waves and of light in air. 1600 w. Comptes Rendus—Nov. 3, 1902. No. 51944 D.

## GENERATING STATIONS.

**Alternators.**

Armature Reactions and Pendulum Effects in Alternators (Ankerreaktion und Pendelercheinungen bei Drehstromgeneratoren). Rudolf Goldschmidt. A graphical and analytical discussion of the reactions in alternator armatures. 1800 w. Elektrotech Zeitschr—Nov. 6, 1902. No. 51935 B.

Some Noteworthy Rotor Construction (Eine Bemerkens Magnetradekonstruktions). F. Tischendörfer. With photographs of portions of large alternators, showing the mannar in which the rotor is built in connection with the fly wheel. 1500 w. Zeitschr d Ver Deutscher Ing—Nov. 8, 1902. No. 51918 D.

The Coupling of Alternators (Note sur le Couplage des Alternateurs). L. Martin. With diagrams showing the method of arranging alternators in step for operation in parallel. 2000 w. Revue Technique—Nov. 10, 1902. No. 51911 D.

**Bordeaux.**

Central Power Station of the Central Railway of France at Bordeaux-Saint-Jean. ? A. Laurent. An illustrated description of the central power plant at Bordeaux where 1500 horse power is generated and electrically distributed. 3500 w. 2 plates. Rev Gen des Chem de Fer —Nov., 1902. No. 51927 H.

**Cambridge, Mass.**

Power Plant of the Cambridge Electric Light Company, Cambridge, Mass. Illustrates and describes this recently completed plant. It is an alternating-current one with a three-phase 60-cycle supply furnished from direct-connected vertical compound condensing generating units. 3200 w. Eng Rec—Nov. 4, 1902. No. 51582.

**Commutation.**

A Contribution to the Theory of Commutation. Alexander Rothert. Translated from the *Elektrotechnische Zeitschrift.* 2500 w. Elec Engr, Lond—Nov. 14, 1902. Serial. 1st part. No. 51854 A.

Sparkless Commutation (Ueber Funkenfreies Kommutiren). P. Prenzlin. A discussion of the arrangement of the carbon brushes of a continuous current dynamo so as to secure sparkless commutation when running in either direction. Two articles. 7500 w. Elektrotech Zeitschr—Oct. 23, 30, 1902. No. 51931 each B.

Special-Shaped Magnet Poles and the Way They Affect Commutation. Fred W. Davies. Describes the principal ways in which the shape of the cores and polepieces of continuous-current machines have been modified in order to make sparkless commutation easier, and thus permit of a more economical design. Ill. 1800 w. Elec Rev, Lond—Nov. 14, 1902. No. 51855 A.

**Compounding.**

Automatic Regulators, and the Compounding of Generating Sets (Les Régulateurs Automatiques et le Compoundage Electromécanique des Groupes Electrogènes). J. L. Routin. Discussing the combination of mechanical and electrical regulation in compounding. 10000 w. Bull Soc Int d Electriciens—Aug., Sept., Oct., 1902. No. 51947 each H.

**Destructors.**

See Civil Engineering, Municipal.

**Dynamos.**

Design of Continuous Current Dynamos. Henry A. Mavor. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Considers the application of results of calculations and experiments to practical design. 4000 w. Mech Engr—Nov. 15, 1902. No. 51849 A.

**Hydro-Electric Stations.**

A Large French Electrical Power Distribution Scheme. An illustrated description of the plant at Saint Georges, near Narbonne, utilising a fall of 100 meters. The power is transmitted 40 kilometers. 2500 w. Elect'n, Lond—Nov. 14, 1902. No. 51857 A.

Canadian Niagara Power Co.'s Development. An illustrated account of the work under construction by this company which will generate 110,000 electrical horse power. 2000 w. Can Engr—Nov., 1902. No. 51634.

Recent European Water Power Plant. An ilustrated description of several plants given in a recent paper before the Engineers & Architects Assn. of Zurich, by Mr. Zoelly. 1600 w. Eng Rec—Nov. 15, 1902. No. 51720.

The Generating Station at Champ (L 'Usine Géneratrice de Champ). A. Lépine. A fully illustrated description of the hydro-electric station situated on the river Drac near Grenoble, France, more than 4000 h. p. are developed and distributed. 6000 w. Bull Soc Int d Electriciens—Aug., Sept., Oct., 1902. No. 51946 each H.

The Hydro-Electric Station at Vouvry, Switzerland (Usine Hydro-Electrique de Vouvry, Suisse). Describing the electric station above Villeneuve, in which the water of Lake Tanay is utilized under a head of 950 metres. 2000 w. 1 plate. Genie Civil—Oct. 18, 1902. No. 51900 D.

The Power Plant and Transmission for the City of Lausanne, Switzerland (Die Kraftübertragung für die Stadt Lausanne.) Dr. Wyssling. Illustrating the plant in which 5,000 horse power is transmitted by continuous current from St. Maurice to Lausanne, a distance of 55 kilometres. Serial. Part I. Elektrotech Zeitschr—Nov. 13, 1902. No. 51936 B.

The Electric Plants of Switzerland (Die Elektrizitätswerke der Schweiz). Richard Lorenz. With map showing the extent to which the hydraulic resources of Switzerland are utilized; more than 160,000 h. p. are developed. 1500 w. 1 map. Zeitschr f Elektrochemie—Oct. 30, 1902. No. 51939 G.

Power Development at Niagara Falls. A. A. Bowman. Describes the Canadian power development at Niagara Falls principally. 3000 w. Can Engr—Nov., 1902. No. 51635.

**Loads.**

On What Lines Shall We Reach New Business to Improve Our Load Curve and Increase Our Net Earnings? George Hayler, Jr. Read at Cleveland meeting of the Ohio Elec. Lgt. Assn. Suggestions from the standpoint of stations operating from dusk to daylight and supplying light only. 1500 w. Elec Rev, N Y—Nov. 8, 1902. No. 51645.

Loads on Electric Stations. Alton D. Adams. Curves and data illustrating the changes of energy outputs from month to month of different supply systems; also illustrates the variations in the ratio of average to maximum loads. 2000 w. Elec Rev, N Y—Nov. 8, 1902. No. 51644.

**Midland.**

The Midland Electric Power Station. Illustrations and information concerning the development of electric power distribution for lighting and traction work at Ocker Hill. 2500 w. Engng—Nov. 14, 1902. No. 51866 A.

**Power House.**

See Street and Electric Railways.

**Rates.**

The Determination of Central Station Rates. C. J. Spencer. Considers the several systems of charging for current. 900 w. Elec Wld & Engr—Nov. 22, 1902. No. 51810.

**Richmond, Ind.**

The Municipal Lighting and Power Plant of Richmond, Ind. Illustrated detailed description. 2500 w. Engr, U S A —Nov. 1, 1902. No. 51514.

**St. Louis, Mich.**

The Water and Lighting Plant at St. Louis, Mich. Brief description of a combined water-works pumping station and electric lighting plant capable of being operated either separately or together, and run by both water and steam power. 1400 w. Eng Rec—Nov. 15, 1902. No. 51723.

## LIGHTING.

**Arcs.**

Experiments upon Alternating Current Arcs at High Pressure (Untersuchungen über den Wechselstromlichtbogen bei Höherer Spannung). Berthold Monasch. Giving curves, showing the results of experiments in dry air and in vacuo for arcs of various lengths. 1800 w. Elektrotech Zeitschr—Oct. 30, 1902. No. 51933 B.

**Nernst Lamp.**

A Recent Advance in Electric Lighting. A study of the Nernst lamp. 3500 w. Elec Rev, N Y—Nov. 15, 1902. No. 51-713.

**Street Lighting.**

Electric Street Lighting. Alex. Dow. Read before the Am. Soc. of Munic. Imp. Considers methods, costs, and municipal ownership of street lighting plants. 3500 w. Munic Engng—Nov., 1902. No. 51-543 C.

## MEASUREMENT.

**Cathode Rays.**

The Measurement of Bodies Smaller Than Atoms. S. N. Taylor. An explanation of how the masses and velocities of the particles which constitute cathode rays are measured. 3200 w. Elec Wld & Engr —Nov. 15, 1902. No. 51714.

**Instruments.**

Faults of Electrical Measuring Instruments and Their Correction. H. Williams. Discusses the general class of troubles common to most types, and their remedy. 2500 w. Am Elect'n—Nov., 1902. No. 51604.

**Magnetometer.**

A Compensation Magnetometer (Kompensations-Magnetometer). Dr. Max Corsepius. Describing an improved instrument for the practical determination of the magnetic properties of various kinds of iron. 1800 w. Elektrotech Zeitschr—Nov. 13, 1902. No. 51937 B.

**Permeability.**

The Permeability of Magnetic Liquids. Fitzhugh Townsend, S. Diamant, and L. S. Thurston. Describes a method of measuring the permeability which involves practically the same idea as the Hughes balance. 700 w. Elec Wld & Engr—Nov. 22, 1902. No. 51809.

**Speed-Time Curves.**

Notes on the Plotting of Speed-Time Curves. C. O. Mailloux. Notes of theoretical and practical observations bearing upon the analysis of the speed-time curve, or the study of its characteristics, and upon its synthesis, or the principles involved in plotting it, with a view to facilitating its use as a "method of precision." 27600 w. Trans Am Inst of Elec Engrs—Aug. & Sept., 1902. No. 51627 D.

**Testing.**

Practical Dynamo and Motor Testing. Charles F. Smith. Describes the method of carrying out a number of typical tests and measurements, pointing out some conclusions to be drawn from the results. 2500 w. Mech Engr—Nov. 8, 1902. Serial. 1st part. No. 51730 A.

**Wattmeter.**

The Olivetti Indicating and Recording Wattmeter (Wattmètre Indicateur et Enrégistreur Olivetti). A. Bainville. An auxiliary motor, controlled by the indicating wattmeter, operates the recording apparatus. 2000 w. Electricien—Nov. 8, 1902. No. 51977 B.

## POWER APPLICATIONS.

**Cement Mill.**

Electric Apparatus in a Modern Cement Mill. An illustrated description of the application of electric apparatus to severe conditions with entire success. 2200 w. Elec Rev, N Y—Nov. 1, 1902. No. 51470.

**Cranes.**

Notes on Crane Design—Solenoids. A. D. Williams. On the use of solenoids in electric hoisting appliances. Gives manner of working at a solenoid to suit an assumed case. 2800 w. Am Mach—Nov. 20, 1902. No. 51784.

Notes on Crane Design. A. D. Williams. Wiring diagram and particulars relating to the electrical equipment of cranes. 1000 w. Am Mach—Nov. 27, 1902. No. 52025.

**Electric Driving.**

Electric Power Applications in Modern Steel Making. John Hays Smith. Describing especially the numerous applications of electric driving in the Edgar Thomson mills of the Carnegie Company. 3500 w. Engineering Magazine—Dec., 1902. No. 51996 B.

**Elevators.**

Electric Elevator Control Systems. H. D. James. Illustrates and describes the fundamental features of some of the representative types of electric elevator control. 2200 w. Am Elect'n—Nov., 1902. No. 51602.

**Food Plant.**

Electrically Operated Food Plant at Niagara Falls. Frank C. Perkins. An illustrated description of the Natural Food plant. Both alternating and continuous currents are utilized, and also a storage battery. 1800 w. Elec Rev, N Y—Nov. 22, 1902. No. 51793.

**Hat Factory.**

Electrical Equipment of a Large Hat Factory. Illustrated detailed description of the power plant of the John B. Stetson Company, at Philadelphia. 1800 w. Am Elect'n—Nov., 1902. No. 51601.

**Mine Hoist.**

Electrically Driven Mine Hoist (Elektrisch Betriebene Fördermaschinen). Illustrating and describing the Ilgner-Siemens-Halske system as exhibited at Düsseldorf. 4000 w. Elektrotech Zeitschr—Oct. 30, 1902. No. 51934 B.

Electric Winding Machine for Colliery Work. From *Glückauf*. Illustrated description of an electric winding engine designed by Tr. Buschmann. 900 w. Col Guard—Oct. 24, 1902. No. 51483 A.

**Mining Plant.**

Electric Drainage Plants (Installations Electriques à Epuisement). J. Loubat. A discussion of the applicability of electric power to the operation of mine pumps. 4000 w. Revue Technique—Oct. 25, 1902. No. 51908 D.

Electric Power on the Comstock. Gives an outline of the history of this noted mine, and a description of the plant supplying electric power for mining and for railway transportation of the raw material. 2500 w. Engng—Oct. 24, 1902. No. 51484 A.

Electrical Equipment of the C. & C. Shaft of the Consolidated California & Virginia Mining Co., Virginia City, Nev. Leon M. Hall. Illustrated description. 1800 w. Mines & Min—Nov., 1902. No. 51560 C.

Electric Transmission Plant at a Lead Mine. Illustrates and describes the complete three-phase electrical equipment installed in a mine in Wales. 500 w. Prac Engr—Nov. 7, 1902. Serial. 1st part. No. 51729 A.

**Mine Pumping.**

Electric Mine Pumping at the Montreal Shaft of the Roche-la Moliere and Firminy Mining Company. Frank C. Perkins. Illustrated description of the plant and its operation. 2000 w. Min Rept—Nov. 6, 1902. No. 51632.

**Motors.**

An Asynchronous Motor with Power-Factor Equal to Unity. A. S. McAllister. A statement of the advantages of the induction motor, with a description of the Heyland motor. 2500 w. Sib Jour of Engng—Nov., 1902. No. 52021 C.

Electric Motors with Variable Speed (Moteurs Electriques à Vitesse Variable). A description of the induction and continuous current motors made by the Oerlikon Company of Switzerland. 1800 w. Génie Civil—Oct. 18, 1902. No. 51901 D.

Polyphase Motors with Four Speeds (Vierstufiger Drehstrommotor). Dr. Hans Behn-Eochenburg. A description of the improved polyphase motors of the Oerlikon works, having speeds of 500, 750, 1,000 and 1,500 revolutions; also continuous current motors with speeds from 350 to 1,600 revolutions. 2000 w. Schweiz Bauzeitung—Oct. 18, 1902. No. 51949 B.

## TRANSMISSION.

**India.**

The Cauvery Power Transmission. Illustrates and describes this interesting transmission in India by which power is transmitted from Cauvery Falls to the Kolar gold fields, a distance from 90 to 100 miles. 3400 w. Elec Engr, Lond—Oct. 31, 1902. No. 51614 A.

**Lightning Arresters.**

The Protection of Overhead Lines Against Lightning (La Protection des Lignes Aériennes Centre la Fondre). E. Dussaugey. An exhaustive study of the construction and operation of devices for protecting electric transmission lines from lightning. 8000 w. Bull Soc Int Electriciens—Aug., Sept., Oct., 1902. No. 51-945 each H.

**Pike's Peak.**

The Pike's Peak Power Plant. An illustrated description. 3000 w. Eng & Min Jour—Nov. 8, 1902. No. 51657.

See also Electrical Engineering, Generating Station.

### MISCELLANY.

**Address.**

Proposed Developments of the Institute. Charles F. Scott. Presidential address delivered at New York. September 26, 1902. Considers the present standing and future possibilities of the Institute. 4800 w. Trans Am Inst of Elec Engrs—Aug. & Sept., 1902. No. 51630 D.

**Discussion.**

Papers by Charles P. Steinmetz, Dr. Samuel Sheldon, Prof. R. B. Owens, Prof. William Esty, Mr. Harold W. Buck, and Mr. R. B. Raymond, at Great Barrington, Mass. Papers on the education of electrical engineers. 13000 w. Trans Am Inst of Elec Engrs—Aug. & Sept., 1902. No. 51629 D.

**Military Application.**

Civilian Co-operation in the Development of Electrical Devices for Military Purposes. Caryl D. Haskins. An appeal for closer co-operation between civilian engineers and the officers of the U. S. Navy and Army in the development of electrical applications. 1200 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52000 D.

Electricity in Its Application to Submarine Mines. John Stephen Sewell. Reviews the objects desirable to accomplish by such a plant, the electrical arrangements and apparatus, testing, etc. 2300 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52001 D.

Electricity in Permanent Seacoast Defenses. George W. Goethals. Explains the conditions of a military post on the coast, and the requirements of the electrical installation and its growing demands. 6500 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52006 D.

Electricity in the Navy. Walter M. McFarland. Remarks mainly with respect to power plants and motor installations on shore, with brief reference to electrical apparatus on war vessels. 3400 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52008 D.

Electricity in the Navy. Harry George. Sketches the development and applications in the naval service for both lighting and power, and compares the United States vessels with foreign navies. Ill. 13500 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52003 D.

Emergency Engineering for Harbor Defense. Dr. Louis Bell. A brief review of work during the Spanish-American war in the harbor at Boston, and the lessons learned. 3500 w. Trans Am Inst of Elec Engrs—Oct., 1902. No. 52010 D.

The Probable Future Developments in the Use of Electricity on Board Ships. F. O. Blackwell. Points out the improvements in sight in marine electric plants, the field for their profitable extension, and some of the recent developments in electrical engineering that may be advantageously employed on shipboard. 6600 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 13—Nov., 1902. No. 51805 D.

**Review.**

Electrical Progress, 1877-1902. Thomas Commerford Martin. Brief review of a period which, with the exceptions of telegraphy and telephony, covers most of the practical applications of electricity, and showing its relation to mechanical engineering. 2000 w. Am Mach—Nov. 6, 1902. No. 51554.

## GAS WORKS ENGINEERING

**Burners.**

The Care and Maintenance of Incandescent Gas Burners. McDougald Dexter. Presented at the meeting of the Am. Gas. Lgt. Assn. Suggestions as to their proper care and maintenance, the importance of inspection, renewals, etc. 2500 w. Am Gas Lgt Jour—Nov. 3, 1902. No. 51497.

**Coke.**

Gleanings from Coke-Oven Practice. Abstract Translation of paper by Herr Hilgenstock, before the German Assn. of Gas & Water Engrs. 4000 w. Jour Gas Lgt—Oct. 28, 1902. No. 51607 A.

**Compressed Gas.**

The Compressed Gas Industries. Editorial discussion of points concerning the manufacture and sale of compressed oxygen and carbonic acid. 1200 w. Engng—Oct. 31, 1902. No. 51622 A.

**Fuel Gas.**

Gases Used Industrially as Fuels. Abstract translation of an article by Dr. Messerschmidt, in the *Zeitschrift für Angewandte Chemie*. 1300 w. Jour Gas Lgt—Oct. 21, 1902. No. 51474 A.

**Gas Engineers.**

The Rise and Recognition of the Engineer. Leon P. Lowe. Read before the Pacific Coast Gas Assn. The part of the engineer in the advancement of the world, especially referring to gas engineering. 2700 w. Jour of Elec—Nov., 1902. No. 51891 C.

**Ignition.**

New Electrical Gas Ignition and Extinguishing Device. Illustrates and describes a device being introduced in England. 1500 w. Jour Gas Lgt—Oct. 21, 1902. No. 51472 A.

**Mantles.**

The Making of Welsbach Mantles. An account of the processes through which the mantle has to pass, with an illustrated description of the new factory at Wandsworth, England, built for the sole purpose of producing these mantles. 5300 w. Jour Gas Lgt—Oct. 21, 1902. No. 51471 A.

The New Plaissetty Mantle—A Strong Competitor. Describes the process of manufacture of this mantle and reports tests made. Ill. 3800 w. Jour Gas Lgt—Oct. 28, 1902. No. 51605 A.

**Naphthalene.**

Further Suggestions for the Elimination of Naphthalene from Coal Gas. Thomas Glover and William Young. Read before the So. Dist, Assn. of Gas Engrs & Mgrs. (England). Presents some considerations of the problem and proposes modifications in the methods of condensation which will effectually reduce the quantity of naphthalene in the finished gas. 4900 w. Gas Wld—Nov. 8, 1902. No. 51726 A.

**Natural Gas.**

Natural Gas in 1901. Extracts from the Mineral Resources of the United States for 1901. 2500 w. Pro Age—Nov. 15, 1902. No. 51684.

**Oldham.**

New Gas-Producing Plant at Oldham. An illustrated general description of extensions comprising a retort house, coal-store and plant regenerative settings, and compressed air stoking machinery. 3200 w. Jour Gas Lgt—Oct. 28, 1902. No. 51606 A.

**Power Gas.**

Producer Gas Plants (Sauggeneratorgasanlagen). Adolf Langen. A discussion of recent forms of producers for the generation of lean gas for use in gas engines. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 8, 1902. No. 51917 D.

**Purifying.**

Grid-Valves. R. J. Milbourne. Remarks on the similarity of the Millbourne gas-purifier valve and those invented by Heer Prins van Doesburgh. Gives illustrations of the Milbourne grid-valve with explanation. 1600 w. Jour Gas Lgt—Oct. 21, 1902. No. 51473 A.

**Retorts.**

Concerning Mr. R. B. Brown's Paper, "Why Milwaukee Did Not Build Inclines." Frederick Egner. A criticism of statements made in paper read before the Am. Gas Lgt. Assn. 1200 w. Jour Gas Lgt—Nov. 11, 1902. No. 51811 A.

Discussion on the Paper by R. B. Brown of Milwaukee, Wis., as to "Why Milwaukee Did Not Build Inclines." Discussion at meeting of the Am. Gas Lgt. Assn. 5400 w. Am Gas Lgt Jour—Nov. 24, 1902. No. 51835.

Why Milwaukee Did Not Build Inclines. R. B. Brown. Read before the Am. Gas Light Assn. States the conditions affecting the carbonization scheme at Milwaukee and explains why the inclined retort system was not considered an economic success. 4600 w. Am Gas Lgt Jour Nov. 17, 1902. No. 51763.

## INDUSTRIAL ECONOMY

**Accident Prevention.**

See Mechanical Engineering, Machine Works and Foundries.

**Address.**

Andrew Carnegie's Rectorial Address. Extracts from an address delivered at St. Andrews University, Scotland, on the subject of "Europe vs. America." 2200 w. Ir Age—Oct. 30, 1902. No. 51443.

North Staffordshire Institution of Mining and Mechanical Engineers. Presidential address of A. M. Henshaw, discussing the coal and iron industry of Great Britain in comparison with the United States, deep mining, waste of fuel, electricity, blast furnace gas, etc. 5800 w. Ir & Coal Trds Rev—Oct. 24, 1902. No. 51488 A.

**America.**

What We May Learn from America (Was wir von Amerika lernen Können). H. von Schwabe. A review of the development of the coal and iron production of America, and the cost of transport, with lessons to be gained for Europe. 2500 w. Stahl u Eisen—Nov. 15, 1902. No. 51955 D.

**Coal Strike.**

Conditions of Labor and Life in Anthracite Coal Mining. Frederick L. Hoffman. Considers 1st, Wages, actual earnings and hours of labor. 2nd, Economic conditions, family expenditures, cost of living, savings, pauperism, etc. 3rd, Health and mortality accident liability, and the waste of productive life and resulting social misery. 2000 w. Eng & Min Jour—Nov. 22, 1902. Serial. 1st part. No. 51838.

Principles Involved in the Settlement of the Coal Strike. Editorial discussing the rights of fair wages and individual liberty. 1200 w. Eng News—Oct. 30, 1902. No. 51451.

The Anthracite Coal Strike Commission. Report of proceedings giving abstracts of several of the statements presented by the companies. 2000 w. Eng & Min Jour—Nov. 22, 1902. No. 51839.

The Labor Problem of the Anthracite Coal Mines. Editorial discussion of the demands made by the recently striking miners, especially the question of wages, outlining a method for improving the conditions. 2800 w. Eng News—Nov. 13, 1902. No. 51687.

The Reply of the Anthracite Mine Operators. Gives the reply to the demands of John Mitchell in behalf of the United Mine Workers of America, and discusses the same. 2000 w. Eng News—Nov. 20, 1902. No. 51823.

The Settlement of the Coal Strike. Walter Wellman. A discussion of the lessons of the strike and the effect upon capital and labor. 3700 w. Rev of Revs—Nov., 1902. No. 51466 C.

**Coal Trade.**

The Course of the Retail Coal Trade. Dr. David T. Day. An outline of the past and prospective course of the retail coal trade, giving an explanation of the effect of the recent strike, the cost of transportation, and the price of coal at various points. 2700 w. Nat Geog Mag—Nov., 1902. No. 51696 C.

**Corea.**

The Economic Situation and Mineral Riches of Corea (La Corée sa Situation Economique et ses Richesses Minières). G. Braecke. A general review of the mineral resources of Corea with statistics for 1899 and 1900. 10,000 w. Rev Univ des Mines—Sept., 1902. No. 51929 H.

**Cost Keeping.**

Cost-Finding Methods for Moderate Sized Shops. H. L. Arnold. The present article deals with the methods of the Bigelow Company, of New Haven, Conn., employing about 200 men in the manufacture of steam boilers. 3000 w. Engineering Magazine—Dec., 1902. No. 51-993 B.

**Education.**

Armour Institute of Technology, Chicago. An illustrated description of the buildings and their equipment, with remarks on the scope of the instruction. 3200 w. Steam Engng—Nov. 10, 1902. No. 51641.

Manchester School of Technology. Illustrated description of this recently completed school in England, the erection and equipment having occupied seven years. 3000 w. Elec Rev, Lond—Oct. 31, 1902. No. 51615 A.

Technical Education in the University of London. J. D. Cormack. Considers some of the needs of the engineering department, the value of scientific training, etc. 5000 w. Engng—Oct. 31, 1902. No. 51624 A.

The Training of Engineers at an American University. Frank Fayant. An illustrated description of the work at Cornell University. 3000 w. Engr, Lond—Nov. 14, 1902. No. 51863 A.

**Fritz Medal.**

The Foundation of the John Fritz Medal. An editorial comment on the significance of this important foundation, with illustrations of the medal and portrait of Mr. Fritz. 1000 w. Engineering Magazine—Dec., 1902. No. 51995 B.

**Industrial Progress.**

A Review and a Glance Forward. John E. Sweet. Notes the progress of the last 25 years, and the future outlook in machine tools. 1500 w. Am Mach—Nov. 6, 1902. No. 51552.

The Retrospect of a Quarter-Century of Progress. Robert H. Thurston. A review of the advance made in technical education and work, especially in America, and the part taken by this paper in the work. 2700 w. Am Mach—Nov. 6, 1902. No. 51549.

**Labor-Trusts.**

Labor-Trusts the Worst. Robert S. Minot, in the Boston *Transcript*. A presentation of the rights and principles involved in labor disturbances. 1000 w. Am Archt—Nov. 1, 1902. No. 51465.

**Municipal Ownership.**

Municipal Ownership. Frank J. Symmes. Read before the Pacific Coast Gas Assn. A discussion of this subject not favorable to public ownership. 5700 w. Jour of Elec—Nov., 1902. No. 51889 C.

**Reichsanstalt.**

The Work of the Reichsanstalt in the year 1901. Summary of the official report on the work of the Physikalische Technische Reichsanstalt. 5000 w. Engng—Oct. 31, 1902. No. 51619 A.

**Trusts.**

The Growth of Trust Companies. Charles A. Conant. Discusses the striking growth shown in the United States, their management, privileges, etc. 5000 w. Rev of Revs—Nov., 1902. No. 51467 C.

**Wages.**

Gift Propositions for Paying Workmen. Frank Richards. Discusses the Premium Plan and the Bonus System, and gives the writer's views. 3000 w. Trans Am Soc of Mech Engrs, No. 0966—Dec., 1902. No. 51877.

The Real Economy of a High Wage Rate. Percy Longmuir. A discussion of the effect of a high wage rate as a stimulus to the industry and capacity of skilled workers, and hence as an undoubted source of economy to the employer. 3000 w. Engineering Magazine—Dec., 1902. No. 51994 B.

**Wastes.**

The Utilization of Wastes and By-Products in Manufactures. Henry C. Kittredge. A report with special reference to the decade from 1890-1900. Reviews refuse wastes, the by-products of the iron and steel industry, and lumber and timber products in the present article. 4800 w. Sci Am Sup—Nov. 15, 1902. Serial. 1st part. No. 51700.

# MARINE AND NAVAL ENGINEERING

**Armor Trials.**

Armor, Projectiles, and Military Explosives. Charles C. Jamieson. A review of important experiments made with projectiles and armor, illustrating various devices, and giving an account of the experiments with Gathmann's shell which won the victory for projectiles. Ill. 5800 w. Jour W Soc of Engrs—Oct., 1902. No. 51-432 D.

**Battleship.**

The Austrian Battleship Babenburg. Illustration and description of the last of a trio of vessels building, with comparison with modern vessels of about the same size. 1700 w. Engr, Lond—Nov. 7, 1902. No. 51749 A.

The Preliminary Official Trial of the U. S. Battleship Maine. J. W. Powell. A description of the vessel with report of tests. Illustrated by 12 plates. 3500 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 4—Nov., 1902. No. 51797 D.

U. S. Battleship Maine. D. S. Mahony. Illustration with detailed description of the vessel and its equipment, and report of trial. 5000 w. Jour Am Soc of Nav Engrs —Nov., 1902. No. 51896 H.

**Boilers.**

See Mechanical Engineering, Steam Engineering.

**Cavitation.**

Cavitation in Screw Propellers (Sur la Cavitation dans les Navires à Hélices). J. A. Normand. A study of the action of screw propellers, deducing the conditions of maximum efficiency. 1800 w. Comptes Rendus—Oct. 27, 1902. No. 51942 D.

**Coaling.**

Supplying Combustible at Sea (Rifornimento di Combustibile in Mare). E. Ferretti. A discussion of the importance of coaling war ships from colliers at sea, with reference to the Miller cable conveyor. 6000 w. Rivista Marittima—Oct., 1902. No. 51967 H.

**Cruisers.**

Cruiser Design. Editorial discussion of the new British cruisers of the Duke of Edinburgh class. 1700 w. Engng—Nov. 14, 1902. No. 51867 A.

The New Armored Cruisers. The majority and minority reports of the Board of Construction of the U. S. Navy Department. 2000 w. Naut Gaz—Nov. 6, 1902. No. 51640.

**Designs.**

Remarks on the New Designs of Naval Vessels. Francis T. Bowles. Remarks on time required to construct naval vessels, the size, offensive and defensive power, with comparisons. Also particulars of U. S. battleships Nos. 18 & 19, Connecticut and Louisiana. 2 plates. 2500 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 11—Nov., 1902. No. 51803 D.

**Destroyers.**

Description and Trials of the U. S. Destroyers Truxton, Whipple, and Worden. John D. Ford. Illustrates the engine and gives detailed description and report of trials. 5600 w. Jour Am Soc of Nav Engrs—Nov., 1902. No. 51895 H.

Trials of the United States Torpedo-Boat Destroyers Bainbridge, Barry and Chauncey. Tabulated results and conditions of the trials which were successfully passed, with illustrations and remarks. 1000 w. Marine Engng—Nov., 1902. No. 51647 C.

U. S. Torpedo-Boat Destroyers Bainbridge, Barry, and Chauncey. Jas. Nelson Alexander. An illustrated detailed description of these vessels and their equipment, with report of trials. 8300 w. Jour Am Soc of Nav Engrs—Nov., 1902. No. 51893 H.

**Disaster.**

The Bullfinch Disaster. Some interesting information as to the cause of the accident which occurred on the torpedo-destroyer Bullfinch, brought out in a recent court decision. 3300 w. Engr, Lond—Nov. 7, 1902. No. 51748 A.

**Electricity.**

See Electrical Engineering, Miscellany.

**Engines.**

See Mechanical Engineering, Steam Engineering.

**Ferry-Boat Trials.**

Progressive Trials of the Screw Ferry-Boat Edgewater. E. A. Stevens and C. P. Paulding. Presents results of the trials of interest to designers. 2000 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 2—Nov., 1902. No. 51795 D.

**Fire Boat.**

Fire, Tug, and Police Boat for the Mexican Government. Illustrated description of the "Triton," the second and larger of two vessels of the same type for the Mexican government. 1000 w. Engng—Oct. 24, 1902. No. 51485 A.

**Flexure.**

The Flexure of Ships (Sul Varo delle Navi). Adolfo Wehmeyer. A graphical study of the pressures upon a ship's hull under varying conditions, with the corresponding flexures produced. Serial, Part I. 6000 w. 2 plates. Rivista Marittima—Oct., 1902. No. 51968 H.

**Large Ships.**

The Economy of Large Ships. A. W. Robinson. Considers the limitations that govern the increase in size, the present stage of development, and the future outlook. 2800 w. Can Soc of Civ Engrs—Adv. proof—Nov., 1902. No. 51529 D.

**Launch.**

The Launch of the Kaiser Wilhelm II. (Le Lancement du Kaiser Wilhelm II.). J. Bosquet. With illustrations showing the details of the launch of this large steamship, including the friction brakes by which the momentum of the hull was checked. 1800 w. Genie Civil—Nov. 8, 1902. No. 51907 D.

**Life Boat.**

Engelhardt's Collapsible Life Boat. An illustrated description of a boat which occupies but little space, and is available for instant use. 1300 w. Am Shipbuilder—Nov. 20. No. 51791.

**Lighthouses.**

The New American Lighthouse System. George Ethelbert Walsh. An interesting account of the efficient lighthouse service, consisting of some 9,000 warning lights and signals. 1600 w. Sci Am—Nov. 22, 1902. No. 51773.

**Liquid Fuel.**

Oil Fuel for the Navy. The report of the Special Board on tests of liquid fuel for naval purposes. Gives particulars of tests made. 8000 w. Ir Age—Oct. 30, 1902. No. 51442.

Use of Liquid Fuel. A review of Rear-Admiral Melville's report, and the experiments conducted by the United States Navy. 9800 w. Marine Rev—Nov. 13, 1902. No. 51703.

**Monitor.**

Description and Trials of the U. S. Monitor Arkansas. C. K. Mallory. 2800 w. Jour Am Soc of Nav Engrs—Nov., 1902. No. 51899 H.

**Naval Engineering.**

Naval Engineering Advance. Its Influence upon Sea Power. George W. Melville. Considers the enginering advance along maritime and naval lines, discussing important achievements. 4800 w. Am Mach—Nov. 6, 1902. No. 51550.

**Naval Engineers.**

The Engineer's Branch of the Navy. Lieut. Carlyon Bellairs. Facts concerning the position of the officers and chief petty officers, the growth in numbers, and other information given in tabular and graphical form. 1300 w. Engr, Lond—Nov. 7, 1902. No. 51746 A.

**Ordnance.**

Naval Ordnance. A review of an interesting report of Admiral Charles O'Neil. 3800 w. Ir Age—Nov. 6, 1902. No. 51570.

The Development of Modern Ordnance and Armor in the United States. Charles O'Neil. A review of the prominent facts in connection with the development and manufacture showing progress made. 17-000 w. 2 plates. Trans Am Soc of Nav Archts & Marine Engrs, No. 10—Nov., 1902. No. 51802 D.

The Tactics of the Gun. A. P. Niblack. A discussion of modern gunnery on battleships, the positions of guns, and the object of tactical manoeuvres, etc. 3 plates. 3000 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 12—Nov., 1902. No. 51-804 D.

**Pipe Joints.**

See Mechanical Engineering, Steam Engineering.

**Repair Ship.**

The Repair Ship a Military Auxiliary to the Naval Fleet in Peace and War. F. W. Bartlett. References to the work of the

Vulcan during the Spanish-American war, with an explanation of the many ways such a ship can be made of value in times of peace. Also outlines the general scheme of such a ship. 19000 w. Jour Am Soc of Nav Engrs—Nov., 1902. No. 51894 H.

**Salvage.**

"Salvage." C. M. Holmes. Paper read before the Insurance Inst. of Victoria, Aust. A brief statement of the law in regard to civil salvage. 3500 w. Aust Min Stand—Sept. 18, 1902. Serial, 1st part. No. 51479 B.

**Schooner.**

Mechanical Equipment of a Seven-Masted Schooner. Illustrates and describes the machinery on the "Thomas W. Lawson." 1500 w. Marine Engng—Nov., 1902. No. 51648 C.

The Seven-Masted Schooner—In General and in Detail. Henry P. Jones. An illustrated description of the "Thos. W. Lawson," the latest example of this type of vessel, with remarks on the present standing of sailing vessels in the American merchant marine. Also editorial. 4800 w. Eng News—Nov. 6, 1902. No. 51592.

**Shipbuilders.**

Technical Training for Shipbuilders. Henry S. Pritchett. Gives the conclusions of those in charge of the teaching of naval architecture and ship design at the Massachusetts Inst. of Technology regarding the instruction desirable. 3200 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 1—Nov., 1902. No. 51794 D.

**Shipbuilding.**

Why It Takes So Long Time to Build and Equip a Naval Vessel for the United States. George W. Dickie. Points out the chief causes of delay in building these vessels, introducing a discussion on methods of design and construction. 4000 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 3—Nov., 1902. No. 51796 D.

**Shipping.**

The Cunard Agreement. W. R. Lawson. A discussion of the British agreements with the Cunard Company, and the Shipping Combine established by J. Pierpont Morgan; the agreement with the German government, etc. 5800 w. Contemporary Rev—Nov., 1902. No. 51705 D.

**Ship Telegraph.**

See Electrical Engineering, Communication.

**Stability.**

Some Problems on the Surfaces of Buoyancy and of Water Lines. C. H. Peabody. A study of the geometry of the surfaces of buoyancy and water-lines as related to the stability of ships. 7500 w. Plate. Trans Am Soc of Nav Archts & Marine Engrs, No. 7—Nov.,1902. No. 51800 D.

**Steamers.**

High-Speed Channel Steamers. Information concerning the design of fast channel steamers, their weight, fittings, etc. 2200 w. Engr, Lond—Nov. 7, 1902. No. 51745 A.

Twin-Screw Steamship "Amur" (Doppelschhraubendampfer "Amur"). Illustrated description of a new steamer constructed for operation in connection with the terminus of the Eastern Railway of China. 2000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Oct. 18, 1902. No. 51912 D.

The Twin-Screw Steamer "Hanoverian." An illustrated description of a typical ship of the combined cargo and passenger type. 1000 w. Engng—Oct. 31, 1902. No. 51620 A.

**Stresses.**

Longitudinal Bending Stress on Damaged Ships. George Crouse Cook. An investigation of this stress which is the most severe to which a vessel in normal circumstances is subjected. Gives illustrations of vessels when floating intact and with various compartments bilged. 21 plates. 7500 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 6—Nov., 1902. No. 51799 D.

**Submarines.**

Submarine Torpedo-Boats—Past, Present and Future. Lawrence Spear. Historical review, with remarks on the outlook for the future. 7 plates. 10300 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 14—Nov., 1902. No. 51806 D.

Submarine Work. Carlo Iberti. Concerning the inventions of Signor Pino, which it is claimed make possible the recovery of sunken ships or objects of any kind from practically any depth. Illustrated description of his working submarine boat. 2500 w. Contemporary Rev—Nov., 1902. No. 51704 D.

The Submarine Boat "Protector." Waldon Fawcett. Illustration with description of this submarine torpedo boat, recently launched. It is the invention of Mr. Simon Lake and is dissimilar to any other submarine boat. 1100 w. Sci Am—Nov. 22, 1902. No. 51776.

To Test Submarine Boats. Information concerning the extended trials the newly-constructed Holland craft is to undergo during the next two weeks. Ill. 1400 w. Naut Gaz—Nov. 13, 1902. No. 51759.

**Tunnels.**

The Strength of Tunnels for Propeller Shafts (Festigkeit von Wellentunneln). F. Kretzschmar. An anayltical examination of the stresses and strains in the shaft tunnels of screw steamers. Serial, Part I. Schiffbau—Oct. 23, 1902. No. 51963 D.

**Vibrations.**

The Vibrations of Steamships, With Special Reference to Those of Second and Higher Period. George W. Melville. A supplementary paper to one on the balancing of engines. Deals with the three questions—1st, Do important vibrations of second and higher periods occur? 2d, Are the unbalanced forces of higher period in the four crank engines important? 3d, Are the forces of higher period sufficient to account for the vibrations of corresponding period? 8 plates. 7000 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 9—Nov., 1902. No. 51801 D.

**Yachts.**

Measurement Rules for Yachts, with Special Reference to Racing Conditions. F. W. Belknap. Discusses whether restriction by rule has hindered or developed the form of highest speed. 3000 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 15—Nov., 1902. No. 51807 D.

Steam Yacht Wacouta. William A. Fairburn. A detailed description of the vessel and its equipment, with report of steam trials. 4700 w. Jour Am Soc of Nav Engrs—Nov., 1902. No. 51898 H.

Turbine Steam Yachts. Brief illustrated description of the turbine yacht Emerald, the largest pleasure yacht yet fitted with the Parsons' turbines. 800 w. Engr, Lond—Oct. 31, 1902. No. 51626 A.

# MECHANICAL ENGINEERING

## AUTOMOBILES.

**Cylinder Cooling.**

Non-Freezing Liquids for Cylinder Jackets. E. E. Keller. An account of investigations made by the writer. 1500 w. Auto Mag—Dec., 1902. No. 52016 C.

**Cylinders.**

The Explosive Wave in Engine Cylinders. Charles E. Lucke. An account of investigations of the causes of abnormally high pressures, which are often dangerous. Ill. 2000 w. Horseless Age—Nov. 19, 1902. No. 51783.

**Designs.**

Comparison of Certain 1902 Design Automobiles with Others Made in 1901 and 1902. George Otis Draper. The writer having used both steam and gasoline machines notes the relative troubles and gives conclusions. 1300 w. Horseless Age—Nov. 12, 1902. No. 51674.

**Fly Wheels.**

The Directional Tendency of the Inertia of the Flywheels and Vehicle Wheels. E. J. Stoddard. A study of rotation with an application to automobile running. 1200 w. Horseless Age—Nov. 26, 1902. No. 52022.

**Gasoline Motors.**

Some Details of Construction in Gasoline Motors. Hugh D. Meier. Discusses details of interest to designers of automobiles. 1300 w. Horseless Age—Nov. 12, 1902. No. 51675.

**German Vehicle.**

New German Automobile. Describes a new invention of Ludwig Maurer which applies the principle of friction in the transfer of power. 600 w. U S Cons Repts, No. 1496—Nov. 15, 1902. No. 51-695 D.

**Motor Cycles.**

The Motor-Cycle Trade in Great Britain. Information concerning the popularity of these machines, the types in demand, desirable features, etc. Brief illustrated descriptions of popular machines. 2000 w. U S Cons Repts, No. 1504--Nov. 25, 1902. No. 51856 D.

**Regulations.**

Automobile Regulations in Europe. A synopsis of the laws governing automobile traffic in the various countries. 7800 w. U S Cons Repts, No. 1490—Nov. 8, 1902. No. 51528 D.

**Searchlights.**

Acetylene Searchlights for Automobiles. From *La Nature*. Considers some of the French searchlights. Ill. 1500 w. Sci Am—Nov. 15, 1902. No. 51692.

**Speed Measuring.**

The Auto-Chronograph. Illustrates and describes an apparatus devised by M. Maurice Espagnent for the precise measurement of speed. 1600 w. Auto Topics—Nov. 22, 1902. No. 51817 C.

**Steam Truck.**

Aultman 4-Wheel Drive Steam Truck for Commercial Use. Herbert L. Towle. Drawings and description of a heavy truck designed to carry a load of 5 tons. 1400 w. Auto & Motor Rev—Nov. 1, 1902. No. 51-495.

**Street Cleaning.**

Automobiles for City Street Cleaning Departments Are Desired. A discussion of the requirements of the work with the aim of securing a self-propelled vehicle that will give satisfactory results. Ill. 2000 w. Auto & Motor Rev—Nov. 15, 1902. No. 51708.

**Touring Car.**

Ward Leonard Gasoline Touring Car Discussed Critically. Herbert L. Towle. This machine is illustrated and discussed in detail. 2300 w. Auto & Motor Rev—Nov. 22, 1902. No. 51790.

**Voiturette.**

The Milnes Voiturette. Illustrated detailed description of a new car attracting attention in England. 2200 w. Auto Jour—Oct. 25, 1902. No. 51476 A.

**Winter Service.**

Winter Use of Automobiles. A. L. Clough. States the technical difficulties of operating motor vehicles in cold weather, discussing each, and aiming to show that an all the year round usefulness is possible. 2200 w. Horseless Age—Nov. 19, 1902. No. 51782.

## HYDRAULICS.

**Electric Pumping.**

See Electrical Engineering, Power Applications.

**Flow.**

The Flow of Water in Wood Pipes. Continued discussion of paper by Theron A. Noble. 4000 w. Pro Am Soc of Civ Engrs—Nov., 1902. No. 52013 E.

**Governor.**

A Water-Wheel Governor of Novel Construction. An illustrated description of the inertia governor of the centrifugal-ball type as used on the Replogle "Differential Relay" water-wheel governor, and the reversing frictional clutch. 1500 w. Eng News—Nov. 13, 1902. No. 51689.

**Hydro-Electric Stations.**

See Electrical Engineering, Generating Stations.

**Plumbing.**

Water Supply Systems in the Ansonia Apartment Hotel. Illustrated description of the supply for a very large 17-story steel and iron building in New York, with housekeeping and family hotel apartments for 1300 tenants. 3000 w. Eng Rec—Nov. 1, 1902. No. 51588.

**Presses.**

A New Principle in Hydraulic Presses. Illustrations and descriptions of applications of the principle invented by Otto Philipp, which saves the loss of power, and does away with the usual hydraulic plant of pumps, accumulator and piping. 1300 w. Am Mach—Nov. 13, 1902. No. 51678.

**Pumping Engines.**

See Civil Engineering, Water Supply.

**Pumps.**

Rotary Pumps. John T. Wilkin. Description is given of the construction and action of rotary pumps, particularly of a two lobe cycloidal pump, and its advantages shown. 2800 w. Trans Am Soc of Mech Engrs, No. 0970—Dec., 1902. No. 51873.

**Sault Ste. Marie.**

The Sault Ste. Marie Water Power Canal. Illustrations and brief description of one of the greatest hydraulic developments in the United States. 1000 w. Sci Am—Nov. 1, 1902. No. 51444.

**Turbines.**

The Jolly-McCormick Turbines at the "Soo." An illustrated description of these turbines with an outline of the history of this type. 1600 w. Ir Age—Nov. 20, 1902. No. 51764.

## MACHINE WORKS AND FOUNDRIES.

**Accident Prevention.**

The Prevention of Accidents to Factory Workmen. Jacques Boyer. A review of French legislation and practice in guarding workmen from accidental injury from machinery. 4000 w. Engineering Magazine—Dec., 1902. No. 51997 B.

**American Tools.**

An English View of American Tools. William H. Booth. Considers the effects of American competition as regards machine tools upon English work. 3000 w. Am Mach—Nov. 6, 1902. No. 51551.

**Boiler Shop.**

The New Boiler Shop of the Alsace Machine Works (Die Neue Kesselschmiede der Elsässischen Maschinenbau-Gesellschaft zu Mülhausen i Elsass). With plans and sections of the buildings, showing arrangement of cranes, tools, etc. 2000 w. Zeitschr d Ver Deutschr Ing—Oct. 25, 1902. No. 51914 D.

**Bolts.**

The Stress on Bolts in Service John H. Barr. Presents the results of some direct measurements of the initial load due to screwing up, and gives what is believed to be a rational treatment of the matter of the resultant load after the external load has been added. 2300 w. Sib Jour of Engng—Oct., 1902. No. 52017 C.

**Brass.**

Railroad Brass Founding—Driving Brasses. C. Vickers. Describes method of molding. Ill. 1300 w. Am. Mach—Nov. 27, 1902. No. 52026.

**Case-Hardening.**

A Job of Case-Hardening. E. R. Markham. Describes a method adopted to remedy troubles met in hardening small pieces. 1000 w. Am Mach—Oct. 30, 1902. No. 51436.

**Casting Pit.**

New Casting Pit at the "Angleur" Steel Works, Belgium. V. Firket. An illustrated description of the new pit in which the machinery is worked entirely by electricity. 1600 w. Ir & Coal Trds Rev—Nov. 14, 1902. No. 51886 A.

**Castings.**

Mixing Iron for Small to Medium Large Size Machinery Castings. P. Burke. Some suggestions from the writer's experience based on the percentage of combined carbon, free carbon and silicon. 1000 w. Foundry—Nov., 1902. No. 51530.

Vacuum Casting. A. E. Fay. Showing the main idea of vacuum casting to be erroneous, and indicating two legitimate uses of the idea. Reviews early inventions utilizing the vacuum idea, and the work of various inventors in order of time. 5400 w. Ir Age—Nov. 6, 1902. No. 51568.

**Cost Keeping.**

See Industrial Economy.

**Cutting Tools.**

The Action of Cutting Tools. William Taylor. From a paper read before the British Assn. Defines true cutting action and the action of shearing and of abrasives. 1000 w. Am Mach—Nov. 27, 1902. No. 52023.

**Dies.**

Combination Dies for an Aluminum Box. H. Robinson. Illustrations of the dies with description of the operation. 800 w. Am Mach—Oct. 30, 1902. No. 51438.

Punching Brass Clock Gears—Movable Stripping Devices. William Doran. Illustrations of punch and die, with descriptions of their use. 1000 w. Am Mach—Oct. 30, 1902. No. 51439.

**Electric Cranes.**

See Electrical Engineering, Power Applications.

**Fans.**

Theory of Centrifugal Blowers or Fans. R. C. Carpenter. Abstracted from new edition of Heating and Ventilating. The present article considers the theory of Daniel Murgue. 1800 w. Sib Jour of Engng—Nov., 1902. Serial, 1st part. No. 52020 C.

**Forging.**

Imperative Conditions for Forging Steel. From a paper by H. F. J. Porter, before the Engine B'ldr's Assn, Outlines the processes considered necessary in the manufacture of high grade forgings. 2000 w. Am Mfr—Nov. 13, 1902. No. 51707.

**Formulas.**

A Development of Machine Shop Formulas. Stanley H. Moore. Considers methods for finding the cost and proportions of machines built in a series of sizes. 2000 w. Mach, N Y—Nov., 1902. No. 51509 C

**Foundries.**

Foundry Progress. Harris Tabor. Reviews the progress made in the casting of metals during the last 25 years. Ill. 1600 w. Am Mach—Nov. 6, 1902. No. 51555.

**Foundry Management.**

Foundry Management in the New Century. Robert Buchanan. The first of a series reviewing the best modern foundry practice in Europe and America. The present paper deals with the economical production of castings. 3500 w. Engineering Magazine—Dec., 1902. No. 51992 B.

**Gear Cutting.**

A Swedish Worm Spur and Spiral Gear Cutting Machine. An illustrated description of a machine for cutting spur and worm gear wheels, and its action. 600 w. Am Mach—Oct. 30, 1902. No. 51437.

**Jigs.**

Jigs for Molding Machines. S. H. Stupakoff. From a paper prepared for the Boston meeting of the A. F. A. Explains the use of a plate in connection with a suitable jig, especially prepared for the purpose, and the advantages. Ill. 2500 w. Foundry—Nov., 1902. No. 51532.

**Lathes.**

A Forty-Four-Foot Pit Lathe. John M. Barnay. Illustrated description of the construction of a heavy pit lathe for the manufacture of electrical machinery. 600 w. Trans Am Soc of Mech Engrs, No. 0968—Dec., 1902. No. 51875.

Railway Wheel Lathe. An illustrated description of an interesting machine recently brought out in England. 400 w. Engng—Nov. 7, 1902. No. 51742 A.

**Locomotive Building.**

The Progress of Locomotive Building in America. Editorial reviewing the figures prepared by the census authorities indicating the progress of this industry in the United States during the last ten years. 1000 w. Engng—Oct. 24, 1902. No. 51486 A.

**Locomotive Works.**

Enlargement of the Baldwin Locomotive Works. An illustrated description of the principal features of the extensive enlargement now under way. 3200 w. Ry Age—Nov. 21, 1902. No. 51834.

Improvements at the Baldwin Locomotive Works. An illustrated account of extensive improvements, mostly additions and remodeling of present equipment. 1500 w. R R Gaz—Oct. 31, 1902. No. 51459.

**Machine Construction.**

A Review of Progress in Machine Construction. Dr. Francis Reuleaux. Reviews the work of this paper during its life of twenty-five years. 1000 w. Am Mach—Nov. 6, 1902. No. 51556.

**Manufacturing Plant.**

The New Works of the B. F. Sturtevant Co., at Hyde Park, Massachusetts. W. B. Snow. Brief general description of the plant. 1500 w. Eng News—Oct. 30, 1902. No. 51449.

**Metal Working.**

Metal Working Machinery. Abstract of a United States Census report, prepared by Edward H. Sanborn upon the production of metal working machinery in the United States during the census year. 4300 w. Ir Age—Nov. 20, 1902. No. 51769.

Perforating Flat and Cylindrical Sheet Metal. Joseph V. Woodworth. An illustrated description of dies and fixtures used and methods of operating. 1600 w. Am Mach—Nov. 27, 1902. No. 52024.

**Milling.**

Milling Cutters. S. N. Brayshaw. Read before the Manchester (Eng.) Assn. of Engrs. On the making of cutters, their use and abuse, giving methods that the writer has found successful. Ill. 4800 w. Mech Engr—Nov. 1, 1902. No. 51612 A.

Milling Machine Feeds. P. V. Vernon. Describes a method of feed driving, which the writer considers efficient and practical. Also editorial note. 2000 w. Am Mach—Oct. 30, 1902. No. 51440.

**Molding Machines.**

The Relation of the Molding Machine to Foundry Labor. C. H. Mumford. Address before the New England Foundrymen's Assn. Discusses the relation of the molding machine to union foundry labor. 3800 w. Ir Age—Nov. 20, 1902. No. 51768.

**Ping Pong Balls.**

American Manufacture of Ping Pong Balls. Joseph Misko. An illustrated description of the method. 1200 w. Am Mach—Nov. 20, 1902. No. 51786.

**Planer.**

Spur Gear Planer. Illustrated description of a machine for planing large spur gears by the use of a single-pointed tool and templets. 500 w. Mach, N Y—Nov., 1902. No. 51600 C.

**Quick Return.**

"The Slow Advance and Quick Return Motion" as Produced by Means of Elliptical Wheels. Prof. C. W. MacCord. Discusses a method depending upon the varying angular velocity of one elliptical wheel, driven by another which revolves with uniform speed. Ill. 1800 w. Stevens Ind—Oct., 1902. No. 51547 D.

**Rolling Mills.**

The Treatment of Machinery in Rolling Mills. G. E. Flanagan. Discusses the bad treatment the machinery usually receives. 1400 w. Am Mach—Nov. 20, 1902. No. 51787.

**Rugby Works.**

The Rugby Works of the British Thompson-Houston Company. An illustrated detailed description of these works and their equipment. 4500 w. Elec Engr, Lond—Oct. 24, 1902. No. 51480 A.

**Screw-Threads.**

Finer Screw Threads. Charles T. Porter. Argues that the existing system reduces the area of cross-section of the bolt unnecessarily, and that the steep inclination allows the nut to jar loose easily. A table for the system proposed is given. 600 w. Trans Am Soc of Mech Engrs, No. 0964—Dec., 1902. No. 51879.

**Shafting.**

Shafting Out of Line. D. B. Dixon. Calls attention to the great waste of power due to imperfect shafting and imperfectly lined up shafting, and gives rules for determining the diameter needed to transmit a given horse power, and other rules for speed, etc. 2000 w. Am Mfr—Nov. 20, 1902. No. 51788.

**Shrinkage.**

An Automatic Foundry Test for Contraction. Asa W. Whitney. Suggests a test for contraction proposed as a rational chill test for cast iron. 2200 w. Ir Age—Nov. 13, 1902. No. 51671.

**Springs.**

Diagrams for Semi-Elliptic Plate Springs. Lawford H. Fry. Gives charts embodying the formulas used in the design of semi-elliptic plate springs such as are used on railroad rolling stock, with method of operation. 1700 w. Am Mach—Nov. 20, 1902. No. 51785.

Springs and Spring Making. C. A. Miller. Presented before the Nat. Ry. Mas. Blacksmiths' Assn. Considers points of importance in regard to the material and manufacture. 1600 w. Ry Mas Mech—Nov., 1902. No. 51524.

**Standardization.**

Analysis by Rote. Discussing the tendency of carrying mechanical standardization too far; or the danger of standardizing methods of testing, and of chemical analysis, as well as materials. 2000 w. Engr, Lond—Oct. 24, 1902. No. 51493 A.

**Tools.**

A Study of Lathe Tools (Note sur les Outils de Tours). A general review of the various forms of modern tools for use in the lathe with numerous illustrations, and a bibliography. 3500 w. Revue de Mécanique—Oct. 31, 1902. No. 51925 E+F.

**Ventilation.**

The Ventilation of Workshops. Reviews the first report of the Commissioners inquiring into the ventilation of factories and workshops. Deals only with general ventilation. 2200 w. Iron & Coal Trds Rev—Nov. 7, 1902. No. 51751 A.

**Wages.**

See Industrial Economy.

## MATERIALS OF CONSTRUCTION.

**Alloys.**

Improved Method of Manufacturing Copper, Yellow Metal, and Naval Brass. H. J. Martin. Describes a new process which utilizes the heat contained in the charge for the purpose of rolling the metal in the "breaking down" and "drawing on" stages. 2500 w. Can Engr—Nov., 1902. No. 51636.

Typical Brassfounders' Alloys. John F. Buchanan. Discusses the causes that have led to the making of inferior metals, and recent innovations in the mixing of alloys. 2000 w. Foundry—Nov., 1902. No. 51533.

**Diseases.**

The Diseases of Iron and Copper (Krankheitserscheinungen in Eisen und Kupfer). E. Heyn. An examination of the changes in the constitution of metals which may be compared to the diseases of living beings. 3500 w. Stahl u Eisen—Nov. 15, 1902. No. 51954 D.

**Microstructure.**

The Microstructure of Iron and Steel. W. C. Post. Address before the Nat. R. R. Mas. Blacksmiths' Assn. Explains the manner of preparing the specimens and the methods of investigating. Ill. 2200 w. Ir Age—Nov. 20, 1902. No. 51767.

**Oil Testing.**

A New Oil Testing Machine and Some of Its Results. Albert Kingsbury. Illustrates and describes the apparatus and methods of testing, arranged with special reference to investigating the effects of either body or viscosity while excluding the effects of the other. 2500 w. Trans Am Soc of Mech Engrs, No. 0973—Dec., 1902. No. 51872 C.

**Porcelains.**

The Composition of Porcelains for Electrical Purposes. Abstract of a paper by Arthur S. Watts, in the *Transactions* of the American Ceramic Society. Gives results of exhaustive tests on electrical insulating porcelain. 3500 w. Elec Wld & Engr—Nov. 15, 1902. No. 51717.

**Wire.**

Experiments with Modern Steel Wire (Versuche mit Neuern Stahldrahtsorten). Julius Divis. An exhaustive examination of steel wire with respect to its use for mine hoisting cables. Serial. Part I. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 1, 1902. No. 51965 D.

## MEASUREMENT.

**Deflection.**

The Deflection of Beams by Graphics. Willibald Trinks. An argument for the design of machinery on the basis of deflection permissible rather than strength, and for the use of graphical methods for determining the amount of deflection. 4800 w. Trans Am Soc of Mech Engrs, No. 0961—Dec., 1902. No. 51881 C.

**Heat Insulation.**

Heat Resistance, the Reciprocal of Heat Conductivity. William Kent. Advocates the use of figures representing resistance instead of conductivity, giving reasons for the change and suggestions for a standard to be adopted. 1800 w. Trans Am Soc of Mech Engrs, No. 0955—Dec., 1902. No. 51884.

**Measurements.**

A Rational Solution of the Problem of Weights and Measures. Sidney A. Reeve. A discussion of the advantages and disadvantages of the metric system and an advocacy of the advantages of a system which subdivides by halves, thirds, and quarters. 4800 w. Trans Am Soc of Mech Engrs, No. 0959—Dec., 1902. No. 51882 C.

**Metric System.**

The Metric System. F. A. Halsey. Discusses the actual use in countries where it has been adopted, showing the confusion of units to have been increased rather than diminished. 20,000 w. Trans Am Soc of Mech Engrs, No. 0956—Dec., 1902. No. 51883 D.

**Surveying Instruments.**

The Use of a Surveying Instrument in Machine Shop Practice. Charles C. Tyler. Describes its use for laying out work where the dimensions are so great as to demand the use of portable machine tools secured to a large floor surface plate, the tools being moved rather than the parts which are being machined. Ill. 4600 w. Trans Am Soc of Mech Engrs, No. 0969—Dec., 1902. No. 51874 C.

## POWER AND TRANSMISSION.

**Accounts.**

Power Plant Accounts. Considers useful data that should be registered in the accounts of the engineer or superintendent of power plants. 3500 w. Engr, U S A—Nov. 1, 1902. No. 51516.

**Cableways.**

Aërial Cable Transportation. William Hewitt. An illustrated review of the various systems and the uses to which they have been applied. Also discussion. 8200 w. Pro Engrs Club of Phila—Oct., 1902. No. 51429 D.

**Compressed Air.**

Air Appliances in the Wabash Shops. An illustrated description of modern appliances for utilizing compressed air. 2300 w. Ry Age—Nov. 7, 1902. No. 51637.

Compressed Air in English Mines. Sydney F. Walker. Discusses arrangements which result in losses, and the methods of overcoming them. 2200 w. Mines & Min —Nov., 1902. No. 51564 C.

Details of Vertical Air-Compressor (King-Riedler Type). An illustrated description. 1500 w. Plate. Engng—Nov. 14, 1902. No. 51870 A.

**Escalator.**

The Escalator. An illustrated description of a notable installation of moving stairways in Macy's new store in New York city. 900 w. Eng Rec—Nov. 8, 1902. No. 51665.

**Gas Power.**

See Gas Works Engineering.

**Power Plants.**

The Development of Power Plants. Fred R. Low. A review of improvements during the last quarter of a century, and the causes of the great advance in power-producing apparatus. 3500 w. Am Mach —Nov. 6, 1902. No. 51553.

The Power Plant. Charles H. Benjamin. The first of a series of papers considering the location, construction, equipment, arrangement, cost and operation of power plants. 3500 w. Engr, U S A—Nov. 15, 1902. Serial. 1st part. No. 51-755.

**Windmills.**

Test and Analysis of a Windmill. Howard V. Meeks and George H. Sander. Graduation thesis. The test was to determine the h. p. developed for different velocities of wind and to see how these results compared with the theory as given by Rankine in formula 4, page 216, "Steam Engine." 1500 w. Stevens Ind—Oct., 1902. No. 51548 D.

## SPECIAL MOTORS.

**Entropy Analysis.**

Entropy Analysis of the Otto Cycle. Sidney A. Reeve. Favors the construction of the entropy diagram for all engine tests. 2500 w. Trans Am Soc of Mech Engrs, No. 0962—Dec., 1902. No. 51880.

**Gas Engines.**

Engines for Blast Furnace Gas (Moteurs à Gaz de Haut-Fourneau). H. Hubert. A review of the development of large gas engines for use with blast furnace gases, with especial reference to the Delamare-Deboutteville-Cockerill engines. 12,000 w. 2 plates. Rev Univ des Mines—Sept., 1902. No. 51930 H.

The Construction of Large Gas Engines (Verschiedeue Constructionen von Grossgasmotoren und ihr Verhalten im Betriebe). H. Reinhardt. Describing many large engines, with especial reference to the use of blast furnace gases. 10,000 w. 2 plates. Stahl u Eisen—Nov. 1, 1902. No. 51948 D.

**Gasoline Engines.**

The Different Grades of Gasoline Engines. Albert Stritmatter. Describes the features of the different grades, indicating the work for which they are adapted. 2300 w. Am Mfr—Oct. 30, 1902. No. 51468.

See also Mechanical Engineering, Automobiles.

**Gas Power.**

See Gas Works Engineering.

**Oil Engine.**

Test of a Priestman Safety Oil Engine. S. P. Howe, and C. Waterbury. Describes the engine and method of testing, giving results. Ill. 3200 w. Sib Jour of Engng—Oct., 1902. No. 52018 C.

## STEAM ENGINEERING.

**Air Pumps.**

Some Notes on Air-Pump Design. C. L. Browne. Considers the important part borne by the condensing apparatus of a steam plant, and the weaknesses in the designs of condensers and air pumps. 1800 w. Elec Engr, Lond—Nov. 14, 1902. Serial. 1st part. No. 51853 A.

**Balancing.**

On the Balancing of Locomotive Engines. W. C. Kernot. Read before the Australasian Assn. for the Adv. of Science. An account of engines which had proved unsatisfactory because there were no balance weights, and the results after being properly balanced. A general discussion of the subject. 3200 w. Engng—Oct. 31, 1902. No. 51623 A.

**Boiler Arrangement.**

The Arrangement of Boilers for Screw Steamers (Anordnung der Betriebskessel für die Propellerbei Schiffen). A discussion of the Leux system of placing water-tube boilers in two tiers. Serial. Part I. 3000 w. Schiffbau—Nov. 8, 1902. No. 51-964 D.

**Boilers.**

Navy Boiler Repairs. Editorial review of a report issued by the British Admiralty making a comparison between ships with shell boilers and those fitted with water-tube boilers. 1700 w. Engng—Nov. 14, 1902. No. 51869 A.

Specification for a Lancashire Boiler 30 ft. by 8 ft., for 200 lb. Working Pressure. Points out the main features to be kept in view and gives dimensions and details.

1700 w. Prac Engr—Nov. 14, 1902. Serial. 1st part. No. 51850 A.

The Water-Tube Boiler in the American Mercantile Marine. William A. Fairburn. Briefly reviews the history of water tube boilers, and considers the features important in designing a boiler suitable for merchant vessels, the types in existence at present, the advantages, the operation, fuel, cost, etc. 19 plates. 26300 w. Trans Am Soc of Nav Archts & Marine Engrs, No. 5—Nov., 1902. No. 51798 D.

**Economizers.**

Economizers. H. F. Schmidt. Gives statements of advantages from the use of economizers. 1700 w. Am Elect'n—Nov., 1902. No. 51603.

**Engines.**

An Economical Mill Engine. Data and results of the feed water tests of a 16 and 40x48 inch Cooper-Corliss engine, and coal test of the plant connected therewith, as given in report of George H. Barrus, with information related. 2200 w. Eng Rec—Nov. 8, 1902. No. 51659.

Marine Engines on the Great Lakes from a Coast Engineer's Point of View. L. D. Lovekin. A comparison with coast practice, showing that the one great aim of the lake engines seems to be reduced cost. Covers the work done on an average freighter. 1600 w. Marine Engng—Nov., 1902. No. 51650 C.

Steam Engines at the Düsseldorf Exposition (Les Machines à Vapeur à l'Exposition de Düsseldorf). P. Dujardin. With illustrations of the more important engines, and a plate showing the large mine pumping engine by Haniel & Lueg. 2000 w. 1 plate. Génie Civil—Nov. 1, 1902. No. 51904 D.

**Feed Water.**

Difficulties in a Steel Mill Caused by Bad Feed Water. A. Osgyani. An account of troubles in a plant at Astoria, Long Island, and means taken to remedy. 1400 w. Ir Age—Nov. 6, 1902. No. 51567.

**Flywheels.**

Flywheel Capacity for Engine-Driven Alternators. Walter I. Slichter. Discusses the function of a flywheel and the causes which make the force on the crank-pin vary during a revolution. 3500 w. Trans Am Soc of Mech Engrs, No. 0967—Dec., 1902. No. 51876.

**Fuel.**

Coal Consumption. R. B. Starbuck. Read before the Toledo Div. of the Cent. Assn. of R. R. Officers. An account of success attained in burning soft coal without smoke according to the Sinclair system. 1000 w. St. Louis Ry Club—Oct. 10, 1902. No. 51526.

**Heat Losses.**

The Loss of Heat from Bare Steam Pipes. Charles P. Paulding. Showing that Péclet's theory of the loss of heat from a surface maintained at constant temperature gives results in agreement with practical tests of the loss of heat from bare steam pipes. 1200 w. Stevens Ind—Oct., 1902. No. 51548 D.

**Indicators.**

The Testing of Indicator Springs (Die Prüfung der Indikatorfedern). E. Roser. Giving descriptions of various methods of testing indicator spring both hot and cold, including the methods and appliances in the leading mechanical laboratories of Germany. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 18, 1902. No. 51913 D.

**Liquid Fuel.**

See Marine Engineering.

**Pipe Joints.**

Troubles with and Remedies for Leaky Pipe Joints. C. A. McAllister. Calls attention to conditions that must be fulfilled in designing flanges, and other things requiring attention to secure tight joints. Especially referring to marine work. 1800 w. Marine Engng—Nov., 1902. No. 51-652 C.

**Pressure.**

The Safe Working Pressure of Steam Boilers. W. H. Wakeman. An explanation in full of rules for determining the safe working pressure. 2800 w. Engr, U S A—Nov. 1, 1902. No. 51517.

**Pumping Engines.**

See Civil Engineering, Water Supply.

**Steam Heating.**

Radiators and Heating. H. H. Kelley. Illustrates and describes many styles of cast iron radiators, with suggestions for determining the heating surface and other requirements. 2000 w. Engr, U S A—Nov. 1, 1902. No. 51515.

The Heating of Buildings with Very Low Pressure Steam ( Le Chauffage des Batiments au Moyen de la Vapeur à Très Basse Pression). H. Heyninx. With details of the apparatus, showing the advantages of low over high pressure steam for heating. 3000 w. Revue Technique—Nov. 10, 1902. No. 51910 D.

**Steam Plant.**

Lighting and Heating Plant at Teachers' College, New York City. Illustrated description of a steam power plant for furnishing light and heat for six buildings. 2800 w. Engr, U S A—Nov. 15, 1902. No. 51754.

Modern Boiler-House Plant. F. J. Warden-Stevens. Discusses the considerations requiring care in the construction of steam-raising plants for large buildings.

2200 w. Archt, Lond—Nov. 7, 1902. No. 51724 A.

Power and Ventilation in the Bush Temple of Music, Chicago. Illustrated description of the mechanical steam plant, especially the arrangement for ventilating and heating the auditorium. 1700 w. Eng Rec—Nov. 8, 1902. No. 51664.

**Steam Turbines.**

The Brady Steam Turbine. An illustrated description of a new steam turbine which derives its motive power from the expansive force of steam, the same as does the reciprocating engine. Its advantages are stated, and tests reported. 1000 w. Ir Age—Oct. 30, 1902. No. 51-441.

The Steam Turbine. Outlines the general principles of the leading types of steam turbines, paying more attention to their thermodynamic than to their constructive features. Ill. 2500 w. Mach, N Y—Nov., 1902. No. 51598 C.

**Stoking.**

An Improved Method of Economical Firing (Eine Neue Feuerungsweise zur Einschrankung des Kohlenmissbrauches). J. H. Mehrtens. A discussion of possible improvements in furnace construction, including the use of hollow grate bars to supply heated air. Serial. Part I. 3500 w. Glasers Annalen—Nov. 1, 1902. No. 51924 D.

Methodical Stoking for Large Installation of Water-Tube Boilers. Dagnino Attilio. Explains the necessity of uniform charging and means taken to secure good results, describing an apparatus for giving the signals automatically. Ill. 1800 w. Marine Engng—Nov., 1902. No. 51-649 C.

**Superheating.**

Results of Tests of Compound Engine Using Superheated Steam (Einige Beschouwingen Over de Resultaten der Stoombeproeven met de Compound-Stoommachine, Werkende met Overhitten Stoom). H. A. Ravenek. Data and results of tests of the engines of the Tubantia Spinning Mills at Enschede. 8000 w. De Ingenieur—Oct. 18, 1902. No. 51959 D.

Steam Superheaters (Surchauffeurs de Vapeur). M. Loffet. With especial reference to the Maiche superheater, with data and results of tests. 2500 w. Revue Technique—Oct. 25, 1902. No. 51909 D.

Superheated Steam. H. L. Koenig. Considers methods of superheating, its use, applications of the system, etc. 2900 w. Sib Jour of Engng—Oct., 1902. No. 52019 C.

The Schmidt System of Superheating Steam (Die Erzeugung und Anwendung von Hochüberthitzten Dampf nach dem System von Wilhelm Schmidt). A discussion of the economy of high superheating, as obtained in the Schmidt apparatus. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 8, 1902. No. 51966 D.

**Testing.**

Trials of a Boiler and Pair of Compound Engines. Michael Longridge. States the object of the trials and gives results. 900 w. Mech Engr—Nov. 8, 1902. Serial. 1st part. No. 51731 A.

**Thermodynamics.**

Second Law of Thermo-Dynamics. Jacob T. Wainwright. An attack upon the law that of a given amount of heat at given temperature only a well defined portion can be converted into work. 2400 w. Ice & Refrig—Nov. 1, 1902. No. 51520 C.

**Valve-Gears.**

Graphical Chart for the Solution of Valve-Gear Problems. W. F. Durand. Describes a form of diagram or graphical representation of the relations involved, which, once drawn, shall contain the solution of all possible problems within the usual working range. 2500 w. Jour Am Soc of Nav Engrs—Nov., 1902. No. 51-897 H.

Method of Laying Out and Adjusting Valves by Means of Valve Diagrams. Report of a lecture by Prof. C. A. Reed on the setting and design of engine valves. 2500 w. Engr, U S A—Nov. 15, 1902. No. 51756.

The Balancing of Valve Gears. A discussion of the force due to friction, the force due to gravity and the force due to inertia, advancing a method by which the crank shaft and valve gear bearings may be relieved of the inertia force in conjunction with the gravity effect. 8 plates. 5500 w. Trans Am Soc of Nav Archts of Marine Engrs, No. 16—Nov., 1902. No. 51-808 D.

## MISCELLANY.

**Aeronautics.**

De Bradsky Airship Disaster. Brief account with illustrations. 700 w. Sci Am—Nov. 15, 1902. No. 51694.

Recent Disasters in Aeronautics (Les Recentes Catastrophes en Aéronautique). G. Espitallier. A discussion of the Severo and de Bradsky accidents showing the necessity for triangular framing in the car suspension in dirigible balloons. 300 w. Génie Civil—Nov. 1, 1902. No. 51906 D.

**Bicycles.**

Dynamic Studies upon Bicycles (Recherches Dynamiques sur les Bicyclettes). Max Ringelmann. Showing the influence of the load, the tire, and the general condition of the machine upon its efficiency. 3000 w. Revue de Mécanique—Sept. 30, 1902. No. 51926 E+F.

**Centrifugal Machines.**

Centrifugal Machines and Their Uses. Bartholomew Viola. Describes the various styles of centrifugal machinery in use for the separating and refining of sugars, cream, and the like. Ill. 3500 w. Trans Am Soc of Mech Engrs, No. 0000—Dec., 1902. No. 51871 C.

**Discussions.**

Topical Discussions and Notes of Experience. 3000 w. Trans Am Soc of Mech Engrs, No. 0954—Dec., 1902. No. 51885.

**Filing System.**

Filing System for Office Use. Henry M. Lane. Describes a system for filing and indexing clippings, etc. Ill. 1700 w. Trans Am. Soc of Mech Engrs, No. 0965—Dec., 1902. No. 51878.

**Liquid Air.**

Liquid Air. Editorial review of a lecture by Dr. Carl von Linde, on "The Technical Application of Liquid Air." Denies the possibility of using it for cold storage on a commercial scale. 2200 w. Engng—Nov. 7, 1902. No. 51743 A.

The Hampson Liquid Air Plant at McGill University, Montreal. Prof. John Cox. Briefly reviews the processes of various experimenters, and gives an illustrated description of the Hampson apparatus and its performance. 1300 w. Can Elec News—Nov., 1902. No. 51709.

**Refrigeration.**

Absorption Refrigerating Machines (Sulle Macchine Refrigeranti ad Assorbimento). R. Manzetti. A thermodynamic study of the absorption class of machines, using the temperature-entropy diagram. 7000 w. Ann d Soc Ing e Arch Ital—No. III, 1902. No. 51970 F.

Lake Superior Cold Stores. General illustrated description of the plant of the Lake Superior Produce & Cold Storage Co., at Houghton, Mich. 700 w. Ice & Refrig—Nov. 1, 1902. No. 51518 C.

The Refrigerating Plant of the Berlin Cold Storage Company (Die Berliner Kühlhäuser der Gesellschaft für Markt und Kühlhallen). Dr. C. Linde. With full details of the construction and machinery of this important cold storage plant in Berlin. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 1, 1902. No. 51-916 D.

Ventilation of Cold Stores. Considers the factors that determine the need of systematic ventilation, the objections urged, and methods used. Ill. 3500 w. Ice & Refrig—Nov. 1, 1902. No. 51519 C.

**Ventilation.**

Ventilation in the Pratt Institute High School, Brooklyn, N. Y. Illustrates and describes the installation of improved facilities in an existing building without the necessity of much reconstruction. 1500 w. Eng Rec—Nov. 22, 1902. No. 51845.

# MINING AND METALLURGY

## COAL AND COKE.

**Bins.**

Cold-Storage Bins in the Pocahontas Field. An illustrated description of some of the early types, their shortcomings and later improvements. 2000 w. Mines & Min—Nov., 1902. No. 51557 C.

**Briquettes.**

The Briquetting of Fuels. R. Schorr. Considers this industry, its development in foreign countries, and what has been done in the United States. 1700 w. Eng & Min Jour—Nov. 8, 1902. No. 51658.

The Manufacture of Briquettes. Editorial review of the processes in use for briquetting fuel, the binding materials used, etc. 2200 w. Engng—Nov. 14, 1902. No. 51868 A.

**British Columbia.**

The Future of the Coal and Coke Supply of British Columbia. W. Blakemore. Showing that the prosperity of the province depends on an abundant supply of the best fuel at a low price, and discusses where to look for the coal needed. 3500 w. Can Min Rev—Oct. 31, 1902. No. 51505 B.

**California Fuel.**

Fuel Conditions in California. John L. Howard. Read before the Pacific Coast Gas Assn. Reviews the history of the coal deposits of California and their development, the imported coal, the use of gas as fuel, oil, etc. 3600 w. Jour of Elec—Nov., 1902. No. 51890 C.

**Coal-Cutting.**

Experiments with Coal-Cutting Machines in the Ruhr District. Bergassessor Kier, in *Glückauf*. An illustrated account of experiments made with American and German machines, describing the machines and reporting results. 3500 w. Col Guard—Oct. 31, 1902. No. 51616 A.

Three-Phase Electric Driving Applied to Coal-Cutting. Roslyn Holiday, in the *Journal of the British Soc. of Min. Students.* Gives reasons for adopting this system, and some of the experiences before success was assured. 1400 w. Col Guard—Oct. 31, 1902. No. 51618 A.

**Coke.**

Arsenic in Coke. A summary of recent researches, showing the occurrence to be general though in small quantities. 1300 w. Col. Guard—Nov. 7, 1902. No. 51739 A.

Coke. N. P. Hyndman. Read before the Pittsburg Foundrymen's Assn. Reviews its history since 1885, its mode of manufacture, quality, etc. 1700 w. Ir Age—Nov. 13, 1902. No. 51672.

See also Gas Works Engineering.

**Colorado.**

The Coal Fields of Routt County, Colorado. Describes a new field on the line of railroad being built between Denver and Salt Lake City, which will doubtless be greatly benefited by the construction of this road. Map. 2500 w. Eng & Min Jour—Nov. 1, 1902. No. 51580.

**Lignite.**

The Lignite Deposits of North Dakota. Frank A. Wilder. The first of three illustrated articles reviewing the nature and extent of these deposits, their fuel value, and present state of development. 2000 w. Eng & Min Jour—Nov. 22, 1902. Serial. 1st part. No. 51837.

**Screening.**

The Screening and Washing of Coal in the Dortmund District of Germany. Abstracted from a paper by Herr Jungeblodt in the *Zeitschrift für das Berg, Hutten und Salinenwesen.* The present article reviews the history of coal washing, tracing the improvements made since the beginning, 50 years ago. Ill. 2800 w. Ir & Coal Trds Rev—Nov. 7, 1902. Serial. 1st part. No. 51753 A.

**Stripping.**

Coal Stripping by Steam Shovel in Kansas. W. R. Crane. An illustrated description of the methods employed, the cost of the stripping operations ranging from 2½ to 3 cents per cubic yard. 3300 w. Eng & Min Jour—Nov. 8, 1902. No. 51655.

**Supply.**

Our Fuel Supply. Abstract of a paper read by James Anderson before the Inst. of Marine Engrs. Considers the increasing demands; the enhanced value; the necessity of conserving; the substitutes for coal, etc. 1900 w. Col Guard—Nov. 7, 1902. No. 51740 A.

## COPPER.

**Assaying.**

The Assay of Copper Bullion. Thomas B. Swift. Gives details of a method for the determination of gold-silver in copper bullion. The essential point is the preliminary amalgamation of the copper to be assayed. 1200 w. Eng & Min Jour—Nov. 15, 1902. No. 51699.

**Blast Furnaces.**

Some Notes on High Blast Furnace Duties. Herbert Lang. Comments on the work done in copper smelting by Messrs. Heywood and Johnson. 3300 w. Eng & Min Jour—Nov. 8, 1902. No. 51656.

**British Columbia.**

The Granby Mines of Phœnix, B. C. C. M. Campbell. An illustrated article describing the development and methods employed. The ores are copper, gold and silver; the chief values being in the copper pyrites. 3600 w. B C Min Rec—Nov., 1902. Serial. 1st part. No. 51677 B.

**Concentration.**

Development of Coarse Concentration in the Slocan District, B. C. Samuel S. Fowler. Considers the silver-lead mining industry of the Slocan, discussing what has been done toward working the deposits economically, giving brief description of the methods. 5000 w. Can Min Rev—Oct. 31, 1902. No. 51506 B.

**Lake Superior.**

Lake Superior Copper. Horace J. Stevens. Gives facts in regard to the condition of the market and the development of some of the principal mines. 1400 w. Mines & Min—Nov., 1902. No. 51561 C.

**New Mexico.**

The Copper Belt of the Burro Mountains, Grant County, New Mexico. D. Bauman. Brief illustrated description. 500 w. Min Rept. Nov. 20, 1902. No. 51831.

**New South Wales.**

Copper in New South Wales. Information concerning the mining since 1845. 800 w. U S Cons Repts, No. 1495—Nov. 14, 1902. No. 51681 D.

**Ontario.**

Copper-Nickel Mining in Ontario. Abstract of a review by T. W. Gibson of the nickel and copper mining industries. 3000 w. Can Min Rev—Oct. 31, 1902. No. 51507 B.

## GOLD AND SILVER.

**Alluvial Mining.**

Hydraulic Sluicing and Alluvial Mining in New Zealand in 1901. A review of the annual reports of the Inspectors of Mines for the Otago goldfields, New Zealand. Ill. 14000 w. N Z Mines Rec—Sept. 16, 1902. No. 51477 B.

**Assaying.**

Methods of Assaying Cyanide Solutions for Gold. T. Lane Carter. A compilation of methods for determining the gold contents of working cyanide solutions. 800 w. Eng & Min Jour—Nov. 15, 1902. No. 51698.

**Cyaniding.**

Details of Cyaniding. Ernst Gayford. An account of the process of milling used by the Horseshoe G. M. Co., Nevada. 2000 w. Min & Sci Pr—Oct. 25, 1902. No. 51498.

**Dredging.**

Dredging for Gold. Enos Brown. Illustrates and describes the work as carried on at Oroville, Butte Co., Cal., giving a brief review of earlier work, and explaining the difficulties. 1400 w. Sci Am—Nov. 8, 1902. No. 51596.

**Placer Mining.**

Placer Mining in Josephine County, Oregon. A. B. Cousins. Describes the conditions and gives an account of what has been done since the discovery of gold in 1851 in this district. Ill. 1000 w. Eng & Min Jour—Nov. 1, 1902. No. 51581.

**Sampling.**

Difficulties and Errors in Sampling Ores of Gold and Other Metals. P. G. Morgan. An account of some sampling from the writer's experience, calling attention to a few sources of error, and suggestions. 1000 w. N Z Mines Rec—Oct. 16, 1902. No. 51851 B.

**Smelting.**

New Smelting Plant at El Paso, Texas. C. W. Arthur. An illustrated description of what is said to be one of the largest and best equipped smelters in the world. 1400 w. Min & Sci Pr—Nov. 15, 1902. No. 51887.

New El Paso, Texas, Oil-Burning Blast-Furnace Plant. C. W. Clapp. Illustrated description of a new plant, interesting because of its labor-saving devices and its successful use of oil as a power developer. 1500 w. Sci Am Sup—Nov. 22, 1902. No. 51777.

Ore Dressing and Smelting at Santa Fe, Mexico. Henry F. Collins. Abstract of a paper presented before the Inst. of Min. & Met. Describes the system of concentration practiced, the smelting, etc. 3300 w. Eng & Min Jour—Nov. 15, 1902. No. 51697.

Smelting on Vancouver Island, B. C. Illustrated description of the smelter built at Crofton, and its operation. 1600 w. Min & Sci Pr—Nov. 8, 1902. No. 51758.

**Sulphides.**

The Thermo Hyperphoric Process. A. S. Firth. A brief account of this process for the treatment of heavy complex sulphide ores containing large quantities of galena and zinc blend, iron and copper, sulphides, and more or less gold, antimony, and manganese oxide with traces of tellurium and free sulphur. 500 w. Jour of Chem & Met Soc of S Africa—Sept., 1902. No. 51727 E.

Treatment of Complex Sulphides. Paper read before the Inst of Min. & Met. (London). A description of the Sulman-Picard process for treating complex sulphide ores. 2300 w. Aust Min Stand—Sept. 25, 1902. Serial. 1st part. No. 51613 B.

**Valuation.**

Notes on Valuing a Gold Mine. T. Lane Carter. Considers some of the principal points in valuing a gold mine. 5400 w. Jour of Chem & Met Soc of S Africa—Sept., 1902. No. 51728 E.

**Witwatersrand.**

An Estimate of the Gold Production and Life of the Main Reef Series, Witwatersrand. Thomas Haight Leggett and Frederick H. Hatch. Abstract of a paper read before the Inst. of Min. & Met., London. A collection of facts upon which estimates may be based, with tabulated results. 2000 w. Eng & Min Jour—Nov. 1, 1902. No. 51578.

## IRON AND STEEL.

**Blast Furnace.**

A Modern French Blast Furnace. Illustrated description of a plant at Cette, on the Mediterranean. 1500 w. Ir Age—Nov. 6, 1902. No. 51569.

The Meehan Furnace Devices. Diagrams and descriptions of the furnace top down comer and explosion pipe. 1300 w. Am Mfr—Nov. 13, 1902. No. 51706.

**Electric Driving.**

See Electrical Engineering, Power Applications.

**Electric Furnace.**

The Electric Smelting of Iron Ore. A. J. Rossi. A statement of what the writer thinks could legitimately be expected from the electric smelting of pig iron in the present state of the arts. 6500 w. Ir Age—Nov. 20, 1902. No. 51766.

**Furnace.**

The Oldest Iron Furnace West of the Allegheny Mountains. Brief account, with illustration, of the "Alliance Furnace," built in 1789. 700 w. Eng News—Nov. 20, 1902. No. 51818.

**Iron-Works.**

Carron and Other Falkirk Iron Works Past and Present. Reviews the history and present condition of these works. 2000 w. Engr, Lond—Nov. 7, 1902. No. 51747 A.

**Molybdenum.**

The Rapid Determination of Molybdenum in Steel. George Auchy. A brief description of the method as now used. 600 w. Ir Age—Nov. 20, 1902. No. 51-765.

**Pig Iron.**

Germany's Progress in the Manufacture of Pig Iron Since 1880. Facts taken from a paper by W. Bruegmann, presented at the Düsseldorf meeting of the British Iron & Steel Inst. 3500 w. Ir Age—Nov. 13, 1902. No. 51670.

Manufacture of Pig Iron. Charles Fox. Read before the Can. Assn. of Sta. Engrs. Considers the classifications according to the purpose to which the pig is applied, the constituents, etc. 1500 w. Foundry—Nov., 1902. No. 51531.

**Segregation.**

Effect of Segregation on the Strength of Steel Rails. Thomas Andrews. Abstract of a paper read before the Soc. of Engrs. Investigations showing the extent of segregation of combined carbon and other elements, the effect, giving typical examples. 5000 w. Ir & Coal Trds Rev—Nov. 7, 1902. No. 51750 A.

## MINING.

**Accidents.**

First Aid to Injured in Mining Accidents. Dr. George W. King. A paper read at Butte meeting of the International Min. Cong. Illustrates and describes methods of treatment and devices to prevent further injury in handling wounded persons. 4500 w. Mines & Min—Nov., 1902. No. 51559 C.

**Breaking Ground.**

Notes on Breaking Ground. T. Lane Carter. Discusses questions of importance in breaking ground economically, and methods of working. 2000 w. Eng & Min Jour—Nov. 1, 1902. No. 51579.

**Briquetting.**

The Briquetting of Minerals. Robert Schorr. On the value of briquetting in connection with metallurgical processes and the manufacture of artificial stone, and the processes in use. 1200 w. Eng & Min Jour—Nov. 22, 1902 No. 51836.

**Electric Hoist.**

See Electrical Engineering, Power Applications.

**Electric Power.**

See Electrical Engineering, Power Applications.

**Electric Pumping.**

See Electrical Engineering, Power Applications.

**Explosives.**

Hathamite. Waldon Fawcett. Information concerning a new powerful explosive which may be handled with impunity, under ordinary conditions. Ill. 600 w. Sci Am—Nov. 8, 1902. No. 51-595.

**Fans.**

Modern Fans. Charles H. Innes. An illustrated article discussing the design of fans with the object of utilizing as much of the energy as possible, the unavoidable losses, etc. Describes the Rateau fan, and the Heenan and Gilbert fan in this article. 2000 w. Engng—Nov. 14, 1902. Serial. 1st part. No. 51865 A.

On the Erection and a Few Tests of a Turbo-Fan and Generator at Hulton Colliery. Alfred J. Tongue. Read before the Manchester (Eng.) Geol. Soc. States the conditions of the ventilation and the position of the shafts prior to the erection of the turbo fan, giving an illustrated description of the plant and testing. Also discussion. 3800 w. Ir & Coal Trds Rev —Oct. 31, 1902. No. 51631 A.

**Firedamp.**

Electrical Tester for Firedamp. G, Leon, in *Annales des Mines*. Illustrated description of the apparatus with statement of the advantages claimed. 1000 w. Col Guard. Nov. 14, 1902. No. 51861 A.

**Haulage.**

The Tail-Rope Haulage System in a Coal Mine. An illustrated account of this system, with information concerning cost of equipment and maintenance. 2000 w. Eng & Min Jour—Nov. 22, 1902. No. 51840.

**Mechanical Engineers.**

The Mechanical Engineer a Factor in Modern Mining, Milling and Smelting. C. H. Repath. Read at Butte meeting of International Min. Cong. Calls attention to illustrations shown at copper mining and reduction works, Butte, Mon. 6800 w. Mines & Min—Nov., 1902. No. 51-563 C.

**Ore Deposits.**

Ores Which Are Deposited by Underground Waters. J. M. Maclaren. Reviews the history of the work done by these waters. 2000 w. Min & Sci Pr—Nov. 15, 1902. No. 51888.

**Prospecting.**

Sizing Up a Prospect. Arthur Lakes. Some of the points to be considered in determining the value when only a small amount of work has been done. Ill. 2000 w. Mines & Min—Nov, 1902. No. 51-558 C.

**Pumps.**

Suspended Pumps in Deep Shafts. W. Price Abell. Read before the Inst. of Waterworks Engrs. An illustrated outline of modern practice of using slung pumps for sinking purposes. 1800 w. Col Guard—Oct. 31, 1902. No. 51617 A.

**Quarrying.**

Pumping Arrangements at the Penrhyn Quarries. Illustrations and explanations showing the conditions under which pumping has to be carried on, and how it is done. 1200 w. Quarry—Nov. 1, 1902. No. 51669 A.

The Quarrying Industry in Havana. C. E. McDowell. Information relating to the quarries in the vicinity of Havana. 2700 w. Stone—Aug., 1902. No. 51789 C.

**Safety Appliances.**

Safety Pit Cages. Are They Desirable. An inquiry aroused by the accident at Tirpentwys Colliery as to a remedy for accidents due to rope breakage. 1400 w. Ir & Coal Trds Rev—Oct. 24, 1902. No. 51487 A.

**Shaft Sinking.**

New Methods of Deep Boring. Illustrated discussion of devices invented by J. Howarth, and W. Pruszkowski, and W. Wolski. 2600 w. Aust Min Stand—Oct. 23, 1902. No. 52143 B.

Shaft-Sinking at the Rheinpreussen Colliery with the Pattberg Drill. L. Hoffman, in *Glückauf*. Illustrates and describes the sinking of two new shafts to depths of 140 and 165 metres respectively. The important feature is the percussive action of the drilling tools being effected by means of a swinging drum, and the continuous removal of the debris. 1600 w. Col Guard—Nov. 14, 1902. No. 51860 A.

**Timbering.**

Timbering in German Collieries. From the report of the Prussian Committee on Falls of Roof and Coal in Mines. Illustrates the manner of timbering, discussing the causes of falls, methods of working, etc. 1700 w. Col Guard—Oct. 24, 1902. Serial. 1st part. No. 51482 A.

**Valuation.**

Mine Valuation by Mining Experts. Editorial discussing a paper by Dr. Rossiter W. Raymond, read before the Am. Inst. of Min. Engrs. 2000 w. Eng News—Oct. 30, 1902. No. 51452.

"Ore in Sight." A. W. Warwick. Discussion of the rulings of the committee of the Inst. of Min. & Met., London. 2000 w. Min Rept—Nov. 20, 1902. Serial. 1st part. No. 51830.

**Winding Engine.**

Conical-Drum Winding Engine. An illustrated description of a large vertical cross-compound winding engine exhibited at Düsseldorf. 1300 w. Engng—Nov. 7, 1902. No. 51741 A.

## MISCELLANY.

**Asbestos.**

Asbestos. A. Leonard Summers. Considers the sources of supply methods of mining, and processes used in manufacturing. 1800 w. Mines & Min—Nov., 1902. No. 51562 C.

**China.**

Mineral Wealth of China. F. R. Wardle. A study in detail of the mineral resources of each province. 1800 w. Min & Sci Pr—Oct. 25, 1902. Serial. 1st part. No. 51499.

**Diamonds.**

Brazilian Diamonds and Carbons. An account of the discovery. Geological formation, methods of mining, etc. 1700 w. Jour Soc of Arts—Nov. 14, 1902. No. 51846 A.

**Lead.**

Volumetric Determination of Lead. W. W. Dods. A commentary on H. H. Alexander's method of standardizing in the volumetric determination of lead by ammonium urolybdate solution. 2000 w. Aust Min Stand—Oct. 30, 1902. No. 52144 B.

**Opals.**

The Opal-Mining Industry and the Distribution of Opal Deposits in Queensland. C. F. V. Jackson. An illustrated article reviewing the history of the development of opal mining, the geology, extent of prospecting, mode of occurrence, varieties, quality, etc., with the progress of the industry. 6500 w. Queensland Gov Min Jour—Oct. 15, 1902. Serial. 1st part. No. 52171 B.

**Petroleum.**

Impurities in Crude Petroleum of Low Gravity. P. W. Tompkins. Read before the Pacific Coast Gas Assn. Considers methods for the rapid determination of the foreign matter contained in petroleum: 3700 w. Jour of Elec—Nov., 1902. No. 51892 C.

The Texas-Louisiana Oil Field. Information from a report by Dr. C. W. Hayes and Mr. William Kennedy. 1400 w. Sci Am Sup—Nov. 15, 1902. No. 51701.

**Phosphate.**

Phosphate Rock in New Zealand. James Park. A description of the deposits recently discovered and the geology of the district. 2800 w. Aust Min Stand—Sept. 11, 1902. Serial. 1st part. No. 51478 B.

**Tasmania.**

Mining in Eastern Tasmania. Begins a discussion of the mining industry and the methods of prospecting and mining which have proved so disastrous. 2000 w. Aust Min Stand—Oct. 30, 1902. Serial. 1st part. No. 52145 B.

**Tin.**

Tin-History and Production. Charles Stevens. Reviews the history of this mineral, giving the sources of supply, the formation of the lodes, etc. 2700 w. Aust Min Stand—Oct. 16, 1902. Serial. 1st part. No. 51848 B.

### CONDUCTING TRANSPORTATION.

**Accidents.**

Railroad Accidents—Year Ending June 30, 1902. Main portions of the fourth quarterly bulletin of the Interstate Commerce Commission. Also editorial. 3500 w. R R Gaz—Oct. 31, 1902. No. 51461.

Train Accidents in the United States in September. Condensed record of the principal train accidents during the month, with comments. 2500 w. R R Gaz—Nov. 7, 1902. No. 51591.

**Collisions.**

The Superintendent, the Conductor, and the Engineman. A summary of the essential points presented in letters criticizing an article by this title which appeared in the issue of July 8. 5000 w. R R Gaz—Nov. 14, 1902. No. 51682.

**Safety Appliances.**

The Development of Safety Appliances on the Prussian-Hessian State Railways (Einrichtungen zur Erhöhung der Betriebsicherheit auf den Preussian-Hessischen Staatsbahnen). H. Scholkmann. With especial reference to the introduction of the block system and improved methods of signaling. 5000 w. Glasers Annalen—Nov. 15, 1902. No. 51956 D.

### FINANCIAL.

**Wages.**

Increasing the Wages of Railway Employes. Editorial discussing the 10 per cent. increase ordered by the Pennsylvania Co., and facts showing why the action cannot be generally followed. Also the general notice to the employes of the Wabash R. R. Co. 1700 w. Ry Age—Nov. 21, 1902. No. 51833.

### MOTIVE POWER AND EQUIPMENT.

**Cars.**

Fifteen and Twenty-Ton Wooden Coal Wagons—North Eastern Railway. Brief description with illustrations. 500 w. Ir & Coal Trds Rev—Nov. 7, 1902. No. 51752 A.

Medical Relief Car of the Prussian State Railway (Die Herstellung der Arztwagen für die Hülfszüge der Preusischen Staatseisenbahn-Verwaltung). H. Schlesinger. With general description of the hospital car and plates of details. 1800 w. 2 plates. Glasers Annalen—Nov. 15, 1902. No. 51957 D.

Special Cars for the Transport of Living Fish (Les Wagons Spéciaux Affectés au Transport des Poissons Vivants). M. Goeury. Describing a special form of tank car used in central Europe and Russia. 3000 w. 1 plate. Rev Gen des Chem de Fer—Nov., 1902. No. 51928 H.

The Extent of Damage Done to Freight Cars While Switching in Terminal Yards and on Sidings. General discussion of this subject. 7000 w. Pro W Ry Club—Oct. 21, 1902. No. 51667 C.

Two-Floor Sheep or Cattle Wagon. Illustrated description of a car used on Argentine railways. The upper floor is raised when it is used for cattle, and lowered into position when the two floors are required for sheep. 600 w. Engr, Lond—Oct. 24, 1902. No. 51494 A.

Vanderbilt Structural Steel Car. Illustrated description of hopper bottom self-dumping coal cars being placed in service on the W. Va. Cent. & Pittsburg. 500 w. Ry Age—Nov. 14, 1902. No. 51761.

**Couplers.**

Side Play Required in Car Couplers. Theodore H. Curtis. Gives formulas for computing the end sill clearance on curves. and length of safety chains. 1100 w. Am Engr & R. R. Jour—Nov., 1902. No. 51511 C.

**Fire Protection.**

The Fire Protection of Railway Trains (Feuerschutzmittel für Eisenbahn fahrzeuge). H. Schumacher. Giving the results of experiments upon the fire-proofing of the materials of construction used for railway cars. 2000 w. Glasers Annalen—Nov. 15, 1902. No. 51958 D.

**Liquid Fuel.**

Oil as Locomotive Fuel. Abstracts from a comparison of oil and coal as locomotive fuel from an economical standpoint, as given in a pamphlet issued by the Baldwin Locomotive Works. Ill. 4000 w. Ry Mas Mech—Nov., 1902. No. 51523.

Oil Fuel for Locomotives. Information from a pamphlet issued by the Baldwin Locomotive Works, discussing at length the subject of oil fuel for locomotives. 3300 w. R R Gaz—Oct. 31, 1902. No. 51462.

**Locomotives.**

Compound Engine—Norwegian State Railways. Illustration, with description of an engine designed to have a great traction effort and yet run smoothly and steadily in traversing curves while hauling pasenger trains. 1500 w. Engr, Lond—Oct. 24, 1902. No. 51491 A.

El Paso—Rock Island Locomotives. Engraving, line drawings and brief description of an engine of the Prairie type. 400 w. Ry Age—Oct. 31, 1902. No. 51500.

New Passenger Locomotives for the Vandalia Line. Illustrated description of recently built engines of the Atlantic type. 1400 w. Ry & Engng Rev—Nov. 1, 1902. No. 51521.

New Passenger Power for the Jersey Central. Illustrated description of recent engines of the Atlantic type furnished for fast passenger service. 300 w. Ry Age—Nov. 14, 1902. No. 51760.

New Six-Coupled Freight Locomotives. Describes the 2-6-2 type on the C. B. & Q. Ry. Ill. 400 w. Am Engr & R R Jour—Nov., 1902. No. 51510 C.

Tank Engines for Norway. Illustration and longitudinal section of two very powerful locomotives constructed for the Dunderland Iron Ore Co., Norway. The specifications are given. 1800 w. Engr, Lond—Oct. 31, 1902. No. 51625 A.

Two-Cylinder Compound Switching Locomotive. Illustrated description of an engine designed for heavy yard work for the N. Y., N. H. & H. R. R. 350 w. Am Engr & R R Jour—Nov., 1902. No. 51508 C.

**Lubrication.**

Automatic Grease Lubricator. Illustrated description of a new device in use on the D. L. & W. R. R. for lubricating locomotive driving and truck journals. 1200 w. Am Engr & R R Jour—Nov., 1902. No. 51513 C.

**Superheating.**

Locomotives Using Superheated Steam. G. Lentz. States the advantages of superheated steam, and the points of importance in their arrangement, illustrating and describing the Schmidt superheater. Also short editorial. 3000 w. Am Engr & R R Jour—Nov., 1902. No. 51509 C.

**Tubes.**

Long Tubes Do Not Vibrate. Description of an experiment made on a fast passenger engine on the L. S. & M. S. Ry. 600 w. Loc Engng—Nov., 1902. No. 51503.

## NEW PROJECTS.

**New Trunk Line.**

Kansas City, Mexico & Orient Railway. Albert Phenis. An illustrated account of Arthur E. Stilwell's project connecting the southwest and Mexico's Pacific coast, what has already been accomplished, and the advantages of the route. 2200 w. Mfrs Rec—Nov. 13, 1902. No. 51702.

**Peru.**

Railway Projects in Peru. An account of a proposed railway by American capitalists to connect the two oceans, crossing the Andes at their lowest point, and reaching navigable waters emptying into the Amazon. 900 w. U S Cons Repts, No. 1499—Nov. 19, 1902. No. 51725 D.

## TRAFFIC.

**Freight.**

Railway Freight Claims. R. L. Calkins. A discussion of the freight claim department, its purposes and relations to other departments. General discussion follows. 11000 w. N Y R R Club—Oct. 16, 1902. No. 51668.

**Light Railways.**

The Limits to the Capacity of Light Railways (Ueber die Grenzen der Leistungs fähigkeit der Kleinbahnen). A. Liebmann. A comparison of the capacity of various light interurban railways in Germany, deducing their probable commercial limitations. 3000 w. Ill. Zeitschr f Klein u Strassenbahnen—Nov. 1, 1902. No. 51973 D.

**Tonnage Rating.**

What Tonnage Rating Really Is. An explanation or draw bar pull, and how it differs from train weights, with description of J. M. Daly's locomotive rating cabinet. 1200 w. Loc Engng—Nov., 1902. No. 51501.

## PERMANENT WAY AND BUILDINGS.

**Convention.**

Convention of the Bridges and Building Association. An account of meeting, with reports, discussions, etc. 7500 w. R R Gaz—Oct. 31, 1902. No. 51460.

**Cut-Off.**

Ogden and Lucin Railway Cut-Off. Don Maguire. An account of the inception of this work and a short descriptive sketch of the cut-off construction, with illustrations. 2500 w. Min & Sci Pr—Nov. 8, 1902. No. 51757.

**Grades.**

Virtual Grades for Freight Trains. A. C. Dennis. An account of experimental investigations to see what minor grades could be run with momentum, and where the stalling point was on those which could not be run. 2000 w. Pro Am Soc of Civ Engrs—Nov., 1902. No. 52011 E.

**Improvements.**

Improvements on the Lackawanna Since 1899. An illustrated review of changes made in equipment and permanent way. 5000 w. R R Gaz—Nov. 14, 1902. No. 51683.

Improvements on the New York Central. Notes from the annual report of the company concerning important improvements under way or contemplated. 800 w. R R Gaz—Oct. 31, 1902. No. 51463.

Improvements on the Pennsylvania R R at Duncannon, Pa. Brief illustrated description of a change of alignment which gives an unobstructed view of the track and eliminates 16 grade-crossings. 500 w. Ry & Engng Rev—Nov. 8, 1902. No. 51-638.

South-Eastern and Chatham Improvements. An illustrated account of widenings, loops, reconstructed stations, and other improvements. 3500 w. Transport —Oct. 24, 1902. No. 51475 A.

**India.**

The Railway Station at Bombay, India. Tipton S. Blish. Illustration and information concerning the most beautiful railway station in the world. 1200 w. St Louis Ry Club—Oct. 10, 1902. No. 51525.

**Interlocking.**

Interlocking at Maumee River Bridge, Toledo. Illustrates and describes an interesting recently completed plant on the L. S. & M. S. Ry. 1400 w. R R Gaz—Nov. 21, 1902. No. 51829.

**Reports.**

Abstracts of Reports at the Convention of the Association of Railway Superintendents of Bridges and Buildings. Reports on auxiliary coaling stations, wearing surface of roadway for overhead bridges and turntables operated by power. 2500 w. Eng News—Oct. 30, 1902. No. 51450.

**Shops.**

Improvements at the Chicago and North Western Shops. Illustrated detailed description of improvements in engine terminal facilities and other departments. 2000 w. R R Gaz—Nov. 21, 1902. No. 51827.

The New Shops of the Atchison, Topeka & Santa Fe. An illustrated detailed description of these large shops and their equipment, with inset. 3800 w. R R Gaz —Nov. 7, 1902. No. 51589.

The Railway Workshops at Addington, New Zealand. Illustrations and account of work at these shops which manufacture all articles used in connection with the railways. St Louis Ry Club—Oct. 10, 1902. No. 51527.

**Signals.**

Electric Distance Signals (Die Einrichtung des Elektrischen Distanzsignales). A. Prasch. An account of the improved Krizik system as used on an experimental section of the Austria State Railways. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 31, 1902. No. 51920 B.

Good Practice in the Use of Distant Signals. W. H. Elliott. Read before the Ry. Sig. Club at Pittsburg. Gives experience of different roads with distant signals, and discusses causes that affect the operation of signals. 3000 w. R R Gaz —Nov. 7, 1902. No. 51590.

**Station.**

Passenger Station for the Wabash R. R. at Pittsburg. Illustrations with brief description. 600 w. Ry & Engng Rev—Nov. 1, 1902. No. 51522.

**Track Elevation.**

Allegheny Track Elevation. H. S. Wilgus. A descriptive account of the work, method of construction, cost, materials, etc. 2700 w. Pro Engrs Soc of W Penn—Oct., 1902. No. 51781 D.

**Train Shed.**

The Erection of the Pennsylvania R. R. Train Shed, Pittsburg. Describes the erection of a 260 x 555 foot building 110 ft. in extreme height, in which the difficulties of erection were increased by the necessity of maintaining uninterrupted service, and many complications due to raising the grades and constructing on the site of the old building. 2500 w. Eng Rec—Nov. 1, 1902. No. 51586.

**Turntables.**

Electrically Operated Turntables. Extract from a committee report to the Assn. of Ry. Supts. of Bridges and Bldgs. Ill. 2500 w. Am Engr & R R Jour—Nov., 1902. No. 51512 C.

## MISCELLANY.

**Management.**

Railroad Management in England and the United States. Charles Hansel. An explanation of the different conditions in the two countries which make the methods incomparable. 1200 w. R R Gaz—Nov. 21, 1902. No. 51828.

**Manufacturing.**

Railway Companies as Manufacturers. Editorial discussing the English practice, the railway companies making everything they use. Does not consider the practice necessarily economical. 1000 w. Loc Engng—Nov., 1902. No. 51502 C.

**M. C. B. Convention.**

A Review of the Master Car Builders' Convention of 1902. J. W. Taylor. Outlines the work done at the last convention. General discussion follows. 12000 w. Pro W Ry Club—Oct. 21, 1902. No. 51666 C.

**Records.**

A Method of Preparing and Preserving Records of Railway Real Estate. Arthur Haviland. Gives a description and contents of record sheets, method of compiling and method of filing records. 3000 w. Eng News—Oct. 30, 1902. No. 51447.

**Berlin.**

The Underground and Elevated Electric Railways in Berlin—Now Completed and in Operation. Frank C. Perkins. Begins an illustrated detailed description of this great engineering undertaking. Serial. 1st part. 1500 w. Sci Am Sup—Nov. 1, 1902. No. 51445.

**Clearing Tracks.**

Removal of Snow and Ice in the Borough of Manhattan, N. Y. W. Boardman Reed. An account of past and present arrangements and methods. 2000 w. St Ry Rev—Nov. 20, 1902. No. 51816 C.

**Discipline.**

The Employing, Training, and Disciplining of Car-Service Employes of the Boston Elevated Ry. William A. Bancroft. Describes the methods used in choosing, training and disciplining the the motormen and conductors. 4400 w. St. Ry Rev—Nov. 20, 1902. Serial. 1st part. No. 51812 C.

**Discussion.**

Papers by A. H. Armstrong, W. B. Potter, and B. J. Arnold, and by C. O. Mailloux and B. J. Arnold, at Great Barrington, Mass. Papers on electric railways. 4000 w. Trans Am Inst of Elec Engrs—Aug & Sept., 1902. No. 51628 D.

**Electric Locomotive.**

A High-Speed Locomotive. Enrico Bignami. Illustrated description of the high-speed locomotive equipped for motors built for 10000 volts, used in the tests at high-speed on the Marienfelden-Zossen military line. 3300 w. Elec Rev, N Y—Nov. 8, 1902. No. 51646.

**Electric Traction.**

Electric Traction on the North-Eastern Railway of Switzerland (Elektrisch Betriebssysteme bezogenauf das Netz der Ehemaligen Nordostbahn). L. Thormann. A discussion of the availability of continuous three-phase and single-phase systems for the Swiss railways. Serial. Part I. 2000 w. Schweiz Bauzeitung—Nov. 15, 1902. No. 51952 B.

Electric Traction on the Italian Railways (La Trazione Elettrica sulle Ferrovie Italiane). G. Semenza. A discussion of the competition of the tramways with the railways for local traffic, and its effect upon the introduction of electric traction on the main lines. Serial, Part I. 2000 w. Rivista Gen d Ferrovie—Nov. 2, 1902. No. 51975 B.

**Express.**

Moving Small Fruits by Electric Railway. Illustrates and describes the arrangements of the International Railway Co. of Buffalo for marketing perishable farm products. 700 w. St Ry Rev—Nov. 20, 1902. No. 51814 C.

**Feeders.**

Transmission Lines for Electric Railways. Alton D. Adams. Discusses when direct feeding to trolley lines ceases to be good practice. 1000 w. St Ry Jour—Nov. 8, 1902. No. 51653 D.

**Fender.**

An Improved Fender Device for Electric Cars (Eine Neue Schulzvorrichtung für Strassenbahnwagen). A. Seyflerth. Illustrating a form of double safety fender used on the electric street railways of Düsseldorf. 1500 w. Elektrotech Zeitschr—Oct. 23, 1902. No. 51932 B.

**Germany.**

Electric Railways in Germany. Information relating to experiments for the reduction of vibration and noise; the use of storage battery cars for local steam lines; high-speed experiments, etc. 1500 w. Elec Rev, Lond—Nov. 7, 1902. No. 51737 A.

**Grand Rapids.**

Novelties on the Grand Rapids Street Railway System. Illustrates and describes devices for the reduction of labor and the improvement of the economy of operation. 1800 w. St Ry Jour—Nov. 1, 1902. No. 51577D.

**Heavy Work.**

An Electrical System for Heavy Railway Work. William Hand Browne, Jr. An illustrated description of the Ward Leonard System. 2500 w. Elec Rev, N Y—Nov. 22, 1902. No. 51792.

**Helios Motors.**

Helios Electrical Equipment of Tramcars. E. M. Collins. An illustrated description of the 20 h. p. size which is typical of all others. 2000 w. Tram & Ry Wld—Oct. 9, 1902. No. 51610 B.

**Interurban.**

The Bremgarten-Dietikon Interurban Electric Railway. Illustrates and describes a short interurban line in Switzerland which combines a passenger and freight business. 1200 w. St Ry Jour—Nov. 1, 1902. No. 51573 D.

The Interurban Electric Railway System of the Union Traction Co. of Indiana. An illustrated detailed description of an electric railway system aggregating 154 miles, its equipment and operation. 7800 w. Eng News—Nov. 13, 1902. No. 51686.

**Paris.**

Notes on Heavy Electric Traction Near

Paris. An illustrated article describing some particulars of the Paris-Orleans line, and giving details of the electric service of the Paris-Versailles line. 1600 w. St Ry Jour—Nov. 15, 1902. No. 51710 D.

**Power House.**

Power House of the Berkshire Street Railway Co., Pittsfield, Mass. Illustrated detailed description. 2500 w. St Ry Rev —Nov. 20, 1902. No. 51813 C.

The Berkshire Street Railway Power House. Illustrates and describes a new generating station at Pittsfield, Mass. 2500 w. Steam Engng—Nov. 10, 1902. No. 51642.

**Right of Way.**

The Private Right of Way. Alton D. Adams. States the advantages of the private right of way, giving information relating to cost, and the growing appreciation, especially in Massachusetts. 2000 w. St Ry Rev—Nov. 20, 1902. No. 51815 C.

**St. Louis Exposition.**

The Electric Urban and Interurban Railway at the St Louis Exposition. W. E. Goldsborough. Information concerning plans for exhibits in this field, including the actual operation and test of railway equipments. 3300 St Ry Jour—Nov. 1, 1902. No. 51572 D.

**Scotland.**

The Rothesay Electric Tramways. Illustrated description of the electrification of a tramway on the west coast of Scotland, the reconstruction and re-equipment work. 2800 w. Tram & Ry Wld—Oct. 9, 1902. No. 51608 B.

**Sleet.**

Removal of Sleet from a Third Rail. George T. Hanchett. Describes methods of dealing with this serious obstacle to traffic. 1200 w. St Ry Jour—Nov. 1, 1902. No. 51575 D.

**Standards.**

Report of the Committee on Standards. Gives the report adopted by the American Street Railway Association, Detroit, Oct. 10, 1902. Ill. 2200 w. St Ry Jour—Nov. 15, 1902. No. 51711 D.

**Statistics.**

A Graphical Representation of Street Railway Statistics. W. C. Gotshall. Gives diagram showing method of plotting street railway operating statistics, stating its advantages and applications. 2000 w. St Ry Jour—Nov. 1, 1902. No. 51574 D.

**Stray Currents.**

The Prevention of Electrolysis. William Brophy. Extract from a paper read before the International Assn. of Fire Engrs. Considers existing conditions as affecting water mains, giving suggestions for their improvement. 2400 w. Ins Engng—Oct., 1902. No. 51539 C.

**Surface Contact.**

Surface Contact. Illustrations with brief description of the Dolter system. 1500 w. Elec Times—Nov. 6, 1902. No. 51718 A.

**Suspension Railway.**

The Elberfeld Suspension Railway. Describes the newer constructive details, the line having been built slowly, and many improvements introduced in the latest work. Also general information relating to the working of the line and its location. Map. 3000 w. Engr, Lond—Oct. 24, 1902. Serial. 1st part. No. 51489 A.

**Terminals.**

The Design of Street Railway Terminals. Describes and illustrates the terminals at the Pan-American exhibition at Buffalo, as well adapted for the rapid handling of crowds. 2100 w. Eng News —Oct. 30, 1902. No. 51456.

**Three-Phase.**

20,000-Volt Three-Phase Plant in France. P. Letheule. Illustrated detailed description of a plant in the extreme southeast of France. 3200 w. Elec Wld & Engr—Nov. 1, 1902. No. 51566.

**Tramways.**

The Development of Electric Tramways (Ueber die Entwicklung der Elektrischen Bahnen). Karl Hochenegg. With many diagrams showing the growth of electric traction in the various countries of Europe and the builders thereof. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 31, Nov. 7,. No. 51922 each B.

**Valtelline.**

Electric Traction on the Valtelline Railway (La Trazione Elettrica sulle Ferrovie della Valtellina). E. Fumero. A very complete account of the road and its equipment and of the hydro-electric power station at Morbegno. 8000 w. L'Elettricita —Nov. 2, 1902. No. 51974 B.

Some Features of the Valtellina Three-Phase Railway. Cesare Pio. Illustrated description of interesting features of a very successful line. 1600 w. Elec Wld & Engr—Nov. 1, 1902. No. 51565.

**Wales.**

The Great Orme Tramways. Illustrated description of a mountain railway in Wales, having steep gradients and sharp curves, worked by cable. 2100 w. Tram & Ry Wld—Oct. 9, 1902. No. 51609 B.

**Zurich.**

The Street Railway System of Zurich. An illustrated detailed description of the construction and operation of a system owned by the city of Zurich, Switzerland. 3900 w. St Ry Jour—Nov. 1, 1902. No. 51571 D.

# EXPLANATORY NOTE—THE ENGINEERING INDEX.

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# THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

# CURRENT RECORD OF NEW BOOKS

Note—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* The Engineering Magazine.

**Civil Engineer's Pocket-Book.**

The Civil Engineer's Pocket Book. By John C. Trautwine, John C. Trautwine, Jr., and John C. Trautwine, 3d. Eighteenth Edition. Size 8 in. by 5½ in.; pp. xxxii, 1079. Price $5.00 (21 shillings). New York: John Wiley & Sons. London: Chapman & Hall, Ltd. 1902.

Trautwine's pocket book needs no commendation or praise, the fact that it has reached its eighteenth edition and seventieth thousand being sufficient evidence of the manner in which it is appreciated by the profession to which it is addressed, and for which it has been the standard book of reference for many years. The present edition represents a very thorough revision, with the inclusion of much new matter and the omission of such portions as had become obsolete. The new matter is of much value, including as it does most complete conversion tables, both of simple and compound dimensions in the English and metric systems, improved tables of logarithms, data concerning the strength of materials, revision of matter on statics, beams, and trusses, and much other useful information. More than 370 pages of new matter have been added, and the whole book has been vastly increased in value by the careful and judicious work which has been done. The value of the earlier editions of this standard work must always be appreciated, but the present revised edition is a book which every civil engineer should possess and use.

**Electrical Dictionary.**

Handy Electrical Dictionary. Compiled and edited by W. L. Weber, M. E. Size, 6 by 2½ in.; pp. 224; diagrams, 45. Price, 50 cents. Chicago: Frederick J. Drake & Co.

A very convenient little reference book, which can be carried in a vest pocket. The definitions are, in general, simple and correct, and in many cases the explanations of terms go further than the bare definition of a word. The list of words is as complete as the limited space permits, and some of the conventional diagrams used in electrical work are also given, such as those representing different types of electrical apparatus.

**Magnetic Tables.**

United States Magnetic Declination Tables and Isogonic Charts for 1902 and Principal Facts Relating to the Earth's Magnetism. By L. A. Bauer. Size, 11½ by 8 in.; pp. 405; figures and illustrations, 29; charts, 2. Washington: U. S. Coast Geodetic Survey, Treasury Department.

The deservedly high reputation of the U. S. Coast Survey for useful scientific work will not be diminished by the present publication by its chief of the division of terrestrial magnetism. This volume is a continuation of the series of papers, begun in 1855, treating of the magnetic declination in the United States. The previous papers contained the magnetic declination tables and the accompanying charts of lines of equal magnetic declination (isogonic charts) for various epochs up to 1900. The results of observations are here brought down to Jan. 1, 1902, and this publication will, when necessary, be followed by others, so bringing the records up to date. The magnetic declination tables, forming the main body of this book, contain about 8,000 entries, and are the most complete tabular presentation of declination values in the United States. The charts contain the lines of equal magnetic declination in the United States and in Alaska, and, for the United States, in addition the "lines of equal annual change." There is a chapter on methods for determining meridian lines and the magnetic declination, and another one setting forth the facts concerning the secular change of the magnetic declination in the United States and outlying territories. A very interesting historical and descriptive essay on the earth's magnetic phenomena and the compass opens this volume, which thus covers its field very completely and is of the greatest value to all who are concerned with the study of the earth's magnetism.

**Mechanics—Problems.**

Mechanics—Problems for Engineering Students. By Frank B. Sanborn. Size, 8 by 5½ in.; pp. 155; illustrations, 15; figures, 47. Price, $1.50. New York: The Engineering News Publishing Co.

This book is filled with live problems. Its author, the professor of civil engineering in Tufts College, has made a judicious selection from modern examination papers and up-to-date text books, but the most characteristic problems are those taken from every-day engineering practice, the realistic effect of the latter being increased by illustrations. The author is convinced that the main object of a course in mechanics should be to prepare a student to solve its problems, and the five hundred examples in this book are chosen with this end in view. They have been grouped under the three general heads of work, force and motion, and there are various subsections, at the beginning of each of which a typical problem is worked out to explain the method and illustrate the principles involved. The student in handling these problems, will feel that he is dealing with real things, of the same nature that will confront him in his engineering career.

### Municipal Sociology.

American Municipal Progress. Chapters in Municipal Sociology. By Charles Zueblin, Professor of Sociology in the University of Chicago. Size, 7½ by 5 in.; pp. 380. Price, $1.25. New York: The Macmillan Company. London: Macmillan and Co., Ltd.

These chapters give an interesting survey of the broadening and quickening activities of American city life. They show what progress has been made, notably within the past decade, in transportation, sanitation, schools, libraries, public buildings, parks and boulevards, public recreation and other departments of municipal administration. Throughout the book there is a sentiment in favor of municipal ownership, which finds definite expression in the last chapter, on "public control, ownership and operation." But without entering into a discussion of the means by which the advance has been gained and by which progress will be made, it must be admitted that although American cities are yet very far from the ideal municipality which is sketched on these pages, the work which has been done and the spirit which has been aroused give every hope for the future.

### Naval Architect's Pocket-Book.

The Naval Architect's and Shipbuilder's Pocket-Book of Formulæ, Rules and Tables, and Marine Engineer's and Surveyor's Handy Book of Reference. By Clement Mackrow. Size, 6½ by 4¼ in.; pp. X, 750; figures, 314. Price, $5. New York: D. Van Nostrand Company. London: Crosby, Lockwood & Son.

The object of this work is to supply all who are connected professionally with shipbuilding with a pocket-book which shall contain all the ordinary formulæ, rules and tables required by them. This matter, before the appearance of the pocket-book, was scattered in various places and some of it was difficult of access, but it has now been carefully gathered and cast into convenient form, and the mere fact that the present is the eighth edition of the work shows that the book has been thoroughly appreciated. In this edition, about fifty pages of new matter have been added, and the volume has been carefully rearranged and revised up to date. The principal tables have been placed together at the end of the book, and among other interesting features is a vocabulary of naval and shipbuilding technical terms, in French and English. This work is to the naval architect and shipbuilder what Trautwine's pocket-book is to the civil engineer, Kent's to the mechanical engineer and Foster's to the electrical engineer.

### Slide Valve.

The Slide-Valve and Its Functions, with Special Reference to Modern Practice in the United States. By Julius Begtrup, M. E. Size, 9 in. by 6 in.; pp. 143; diagrams and illustrations, 90. Price, $2. New York: D. Van Nostrand Company. London: E. & F. N. Spon, Ltd.

Besides the common slide-valve, piston valves, Corliss valves, semi-rotary or oscillating valves and other valves whose sliding surfaces are cylindrical, are included in this treatise. Typical pump valves, as well as steam-engine valves, are also considered. A great many valves in practical use are described and well illustrated, and diagrams are shown wherever advisable, as it is believed, with good reason, that verbal treatment should be supplemented by graphical representation. A successful endeavor has been made to present the subject matter in a condensed form, as being best adapted to the requirements of practical men, and the author has in this respect followed the suggestions of an extensive personal experience.

## BOOKS ANNOUNCED.

Trades Waste, With Special Reference to the Prevention of River Pollution. By W. Naylor, F. C. S., A. M. Inst. C. E. Price, $6.50. New York: D. Van Nostrand Company.

Irrigation Institutions. By Elwood Mead, C. E., M. S. Price, $1.25. New York: The Macmillan Company.

Year Book for Texas for 1902-3. Edited and published by C. W. Raines, Austin, Tex. pp. 440. Price, $2.

Furnace Draft: Its Production by Mechanical Methods. By William Wallace Christie, M. E. Hand-book size; pp. 52. Illust. Price, 50 cents. New York: D. Van Nostrand Company.

Metallurgical Laboratory Notes. By Prof. H. M. Howe. Price, $2.50. Boston, Mass.: Boston Testing Laboratories.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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# THE OPENING OF THE ALASKAN TERRITORY.

*By Harrington Emerson.*

An acknowledged authority recently said: "Alaska will in the next thirty years produce more mineral wealth than the whole of the United States has produced in the thirty years just ended. No one has any conception of the possibilities of that country, to say nothing of its vast, almost incomprehensible extent." But Mr. Emerson is one of the few who have an adequate conception of the future of Alaska, and his estimate of it is based on extensive and intimate personal knowledge of the country under all sorts of conditions. The article following was written while returning from his most recent winter journey to the region. The illustrations are from photographs by E. A. Hegg and Kinne, and are copyrighted and may not be reproduced without permission.—THE EDITORS.

THE west, the old west of boundless natural resources and pathless solitude, to yield homes for millions yet unborn, is not exhausted. Governments and peoples do not realize it, but it lies there to reward the pioneer with greater and quicker returns than have been given by any part of western Europe or of temperate North America. The new and unsubdued west today is Alaska, almost to a mile one-half larger than the thirteen original American Colonies, very nearly twice the size of California, Oregon and Washington, as large as Great Britain, Denmark, Sweden, Norway, and the German Empire, and with a better climate and greater natural resources than an equal area of northern Europe supporting 10,000,000 inhabitants. This land, so rich, so fertile, has a seacoast of 23,000 miles everywhere accessible.

The Yukon, the fourth largest river in the world, navigable for more than 2,000 miles above its mouth and running in a great semi-circle from southeastern to northwestern Alaska, forms a natural highway. All this was known long ago; but it was not known that the interior contained 100,000 square miles of farming lands and almost limitless areas of the richest mineral lands in the world. It is in this unsubdued country that thousands of miles of railroad must be built, that great areas will open for settlement, absorbing and keeping busy two million workers as fast as they choose to go.

AN ESKIMO UMIAK LANDING AT NOME. THE DOG TEAM IS THE MODE OF SUMMER TRAVEL ON THE BEACH.

Alaska is a pathless country, and except as to its very accessible seacoast and the banks of the Yukon, it stands today where Europe was 2,000 years, and the United States 200 years, ago. The natives, gathered along the seashore and the river courses, always use water as their highway winter and summer. When not in boats they travel in dog sleds over the level ice of the frozen rivers or bays. In their boats there was traffic from Point Barrow in the Arctic for 3,000 miles down the coast to Puget Sound, and formerly a very considerable international trade was similarly carried on by way of Bering Strait, Chinese wares coming eastward and furs going westward. The kyak a small one-holed skin boat, the umiak, also a skin boat, will hold fifty people and all their belongings, and it is both a sea boat and a river boat. In summer away from the water the country is impassable, and the difficulties of transportation, as well as its importance for every enterprise, are inconceivable to those whose outfit, sole means of support, has not been landed on a bare beach, with a rising tide or storm threatening immediate destruction. There are a few extraordinary pioneers who without supplies, sometimes without firearms, will pass through 800 miles of trackless country, dressed and living like the natives. These men are comparable to the old *coureurs de bois* and the *voyageurs*, and their example is not to be followed. Had it not been for the natural summer highway of the Yukon, there could never have

A NATIVE EXPRESS IN SUMMER AT NOME.

been such a camp as Dawson. The head passes of the Yukon and the river itself were at that time the only possible direct road to the Klondike. Under such conditions the pack horse adds little to the solution of the problem. He cannot both work and forage. Men "packers" were at one time paid as high as 60 cents a pound for packing over the Chilcoot Pass, but the rate had been 10 cents. Over the White Pass, where horses could be used, the rates were never lower than 10 cents, and often 20 cents. Horse trains were maintained only by a constant fresh supply of horses from the south, few animals surviving more than two or three trips. Of 3,800 horses taken north in 1897, all but 30 died on the trail. To cheapen transportation a wagon road was hastily built in 1898 and a toll levied of 2 cents a pound. In 1899 this was succeeded by a railroad, and freight rates have fallen from the original maximum of 60 cents a pound for 40 miles, from water to water, to $3.75 to $5.50 per hundred pounds for the 2,500 miles from San Francisco or Puget Sound to Dawson. It is 112 miles by rail from tide water over the 2,800-foot pass to White Horse, below the dangerous rapids of the upper river, and to Dawson by the river it is 451 miles further. The fare from Skaguay is $70, and the fastest time made, 32 hours. In winter a sleigh road not following the Yukon, and therefore over 100 miles shorter, is opened north of White Horse to Dawson. The rates scheduled at the beginning of the winter were $165 per passenger, and for baggage in excess of 25 pounds, 40 cents to 50 cents a

HAULING THE UNITED STATES MAIL WITH REINDEER, NOME, ALASKA.

pound; but competition has cut the rate to $75, with extra charges of $5.50 a day for meals and bed. In the early part of the season the time was nine days, but it is hoped to cut this down to four when the snow road is hard and smooth. Scheduled freight rates are 30 cents to 50 cents a pound. In the year 1901 the White Pass Railroad carried 33,471 tons of freight and 16,472 passengers, receiving from passenger traffic $252,932.71 and from freight, express, mail, and telegrams $1,505,132.64, an average for freight of $43 a ton for 112 miles. Operating expenses, naturally heavy, were 42.42 per cent. of the receipts. The first cost of this road, including many expensive franchises and the buying up of possible rivals, was $4,250,000, and in the first season its gross receipts were officially reported to exceed $4,000,000, with operating expenses of about $1,000,000. The actual facts as to this highway into Alaska and the Yukon Valley are given to show the great difficulties and expense of transportation in opening up a new country, where in spite of a rapid fall in rates after the first season, a successful transportation enterprise will usually pay for itself with one year's earnings.

It causes regret to Americans that this brilliant undertaking, conceived and executed by American engineers, could find no American backers—that London, unhampered by the timidity which afflicts New York in presence of a new region, boldly and promptly investigated, financed, and carried it through. The headquarters of the road have been moved from the United States to Vancouver, and the great bulk of the freight is no longer from the United States but almost wholly from Canada. As long as the British know how to grasp the new trade of the world, when and where it is most profitable, they have no immediate cause to worry about German and American competition.

Besides having enjoyed thus far the monopoly of the shortest entrance to the Yukon valley, the White Pass will remain the only approach to the rich Atlin country, a lake region just beyond the coast range, which is slowly but surely developing, producing this last season nearly $1,000,000 in gold. Atlin and the upper Yukon country will always be exclusively tributary to this road. As there is no other pass through which a road can be built, for an indefinite period the revenues of the White Pass route may be counted on to increase, but of the rich Klondike region with Dawson as its center it is likely very soon to be dispossessed. From the Stewart River 72 miles above Dawson to Nulato below the Koyukuk River, a distance of just a thousand miles, there are nearer and better seaports than Skaguay. The best of these is the bay of Valdez, 10 miles long and 3 wide, as protected and beautiful as a Swiss lake, and nearest of all salt-water harbors to Dawson. The first pioneers who were bound for this valley in 1898 attempted to reach it by passing over a glacier 4,000 feet high, and as they had to do their packing wholly by man force (twelve miles) the hardships endured were frightful. There is stirring reading in the United States Government reports made by Major Abercrombie, who

WINTER FREIGHTING OVERLAND, DAWSON, YUKON TERRITORY.

has traveled more extensively in this part of Alaska than any other white man. "Of the 4,000 who tried to go into the Copper River Valley in 1898 three fourths turned back the same season." Of the few who remained, "hundreds were dying of starvation beyond the Coast Range."

In 1900 and 1901 Major Abercrombie built a government trans-Alaskan military trail from Valdez into the Copper River valley. He paid no attention to the river route, nor to the twelve-mile short cut over the glacier, but surveyed and built a new road up the Lowe River and over a pass only 1,700 feet high, or 1,200 feet lower than the White Pass. Last winter over this road the freight rate to Copper Center, 103 miles, was 48 cents by dog team; during the summer by pack horse it rose to $1.50 per pound, as mud is much more difficult traveling than snow and ice. In October, 1900, the mail schedule from Valdez to the American Yukon was reduced to 20 days, and in April, 1901, the trip was made by the mail carriers in 13 days. Beginning the first of January, 1903, the mail contractors put on a weekly stage, four trips each way monthly between Valdez and Dawson. This winter, for the first time, it will be possible for American mails and American passengers to go to the American Yukon as quickly and as cheaply as over the Canadian route.

WINTER FREIGHTING ON THE ICE, LAKE LINDERMAN.

(Copyright, 1898, E. A. Hegg.)

Five large ocean steamers, besides many sailing vessels, run each

DUTCH HARBOR, ALASKA. FLEET WAITING FOR THE ICE TO SOFTEN SO THEY CAN FORCE THEIR PASSAGE THROUGH IT TO NOME.

month between Puget Sound and Valdez, which is also connected by telegraph line with Eagle, Dawson, and the outside world. The increase of travel by this route is due to the discovery that the Copper River valley promises to be a great agricultural region, capable of affording homes to thousands of settlers, who will go there not because they can start bonanza wheat farms, but because the proximity of the great mining camps will give them a very high return for all

MINERS LANDING ON THE BEACH NEAR PORT CLARENCE, SEWARD PENINSULA.

SURF AT NOME, ALASKA.

they can raise. Fresh milk and butter, eggs and poultry, fresh beef and mutton, hay and oats for animals, fresh vegetables for men, command fancy prices. John F. Rice, Quartermaster's Clerk, in his official report to Major Abercrombie states that the city of Eagle is second only to Dawson in importance, that the route from Eagle to Valdez presents no such obstacles as routes through the Rocky Mountains or Cascades, that there is an abundance of grass from May until October, that the natural food resources of Central Alaska are caribou, moose, brown and black bear, mountain goat, geese, duck, grouse, salmon, pickerel, perch, bass, whitefish, trout, pike, and grayling.

It is, however, not the agricultural resources that will immediately attract the largest influx of population and capital. About 140 miles from Valdez in the Chittyna valley are very great copper deposits, which during the last season have been visited by many experts. Some of the ores run 85 per cent. copper, and there are many thousand tons in sight assaying 16 per cent. A great mountain slide has occurred in this region, revealing, it is claimed, as much as 40,000,000 tons of high-grade copper ores. Valdez Bay and the low pass north of it are the American gateways to the Yukon valley, and already a railroad has been surveyed and partially graded to the interior, for the copper, though it can be quarried like the iron ores of Lake Superior, without a railroad will remain worthless. The railroad itself is assured an unlimited tonnage. It is the shortest line to Dawson and the Yukon valley, and which is of more importance, it can carry supplies delivered at Valdez from sailing vessels or deep-draft ocean steamers in all the months of the year, with only one break of bulk at Valdez, and also reach the deep navigable Yukon and the Koyukuk a month earlier than by the Yukon mouth, which is closed by Bering Sea ice until July 1. As shown in the history of the White Pass Railroad, the ingoing traffic would be in itself sufficient to warrant a railroad, but from Dawson the only export is gold, about 70 tons a year, while this road will not only carry all the United States Government troops and supplies, for which many hundred thousand dollars are spent, but it will have the unlimited outbound tonnage of high-grade copper ores, which, with a freight rate of $2 a ton from Valdez to the smelters of Puget Sound will scarcely be treated in the interior.

It is not too much to expect that improvement in transportation facilities alone will convert Central Alaska into as densely a populated and prosperous a region as Colorado, as the Black Hills of South Dakota, as the rich mining region of British Columbia.

There is another part of Alaska waiting for transportation facilities. It is not so dazzling as the Klondike nor as vast as Central Alaska, but it is perhaps richer than either of them.

Far to the northwest lies the Seward Peninsula, suggesting on the map an animal's head snarling across Bering Strait at the nearby Siberia. By rivers and sea it is almost wholly separated from the

LANDING THROUGH THE SURF AT NOME.

mainland, and though comprising but 3 per cent. of the area of Alaska, or 20,000 square miles in 600,000, it has yielded for the last three years nearly 75 per cent. of the gold output, in spite of the increasing yield of the great quartz mines of the southeast, near Juneau. Although the most distant region of North America, 2,700 statute miles from Puget Sound, it owes the rapid exploration and development of its coast to the fact that an all-water route was open to its shores, and that freight still costing a minimum of $70 a ton into Dawson is being landed on the Nome beach for $10 a ton. Passenger rates, higher in the first rush, have fallen to $40 and $50 first-class and $20 or $25 steerage.

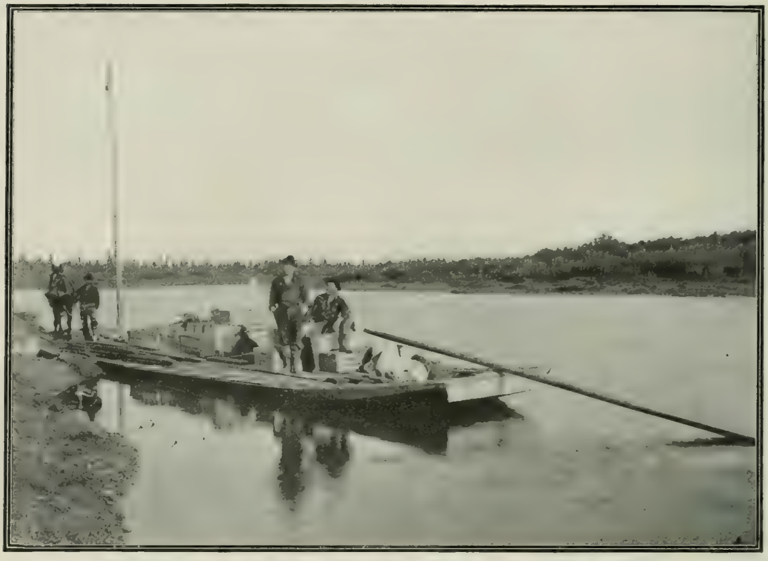
WRECKS ON THE NOME BEACH AFTER A STORM.

Owing to the freedom from hardships, as well as the low coast and shortness of time required, impelled by stories that were indeed true of rich golden beaches, about 25,000 people and their chattels landed on the low sandy spit at Nome and were left to the mercy of surf and storm. The Eskimo, very numerous along this coast, who have none of the aloofness of the Indian, came in their umiaks, big skin boats that can carry fifty people and all their belongings, and made camp with the whites; but the Eskimo, needing no barometer, intuitively flee several days before a storm. Not so the whites, who every year have been caught. In September, 1900, when there were more than 12,000 campers along the beach, the surf rolled in, wrecked much of the

LANDING PASSENGERS AND SUPPLIES OVER THE ICE AT NOME.
Cheaper than lightering through the surf. This explains the early rush every season.

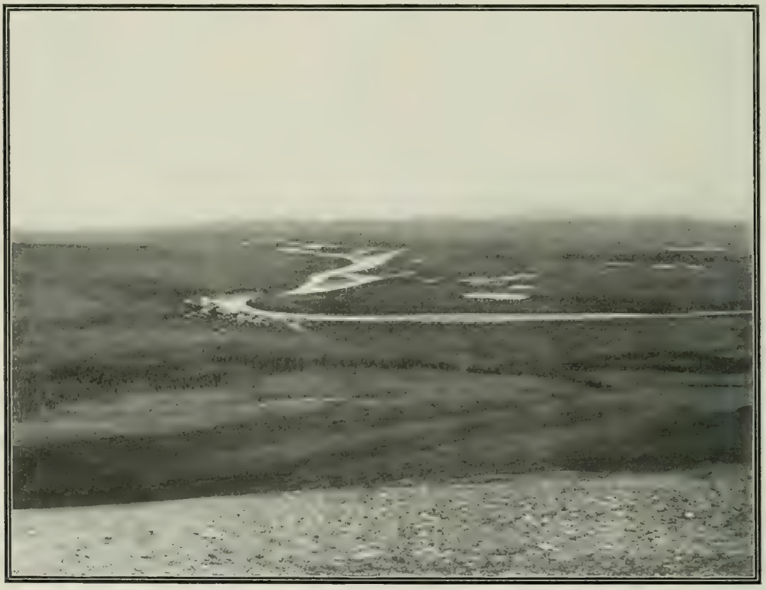
shipping in the offing, and destroyed about $1,500,000 of miscellaneous property on the beach, and every year since, similar if not so severe disasters have occurred. Driftwood, piled high landwards from Nome, shows that on occasion the sea sweeps the whole site of the present city. This is not the only danger. Another is fire. The streets are narrow, and the houses —flimsy wooden structures—stand in serried rows. Because of the cold there are hot fires everywhere. There are few brick chimneys, and in winter there is no water supply. If a serious fire should occur in midwinter, destroying shelter, food and fuel, no relief could reach the stricken people. The nearest open port on the Pacific is 500 miles to the southeast. It is 1,711 miles from Dawson, with no roads to either place. Bering Sea is in the same latitude as the Baltic, and like the Baltic is shallow and brackish owing to the many rivers which empty fresh water and silt into it. In winter surface ice readily forms, extending 300 to 400 miles south of Nome, effectually isolating the city from November 1 until June 1. This is unendurable, and three projects are under consideration to effect communication throughout the

DERRICK FOR UNLOADING SCOWS AND BARGES, NOME BEACH.



FREIGHT BOAT OF THE NIUKLUK RIVER. CARRIES 7 TONS.
The horse tows it up-stream, riding down in the boat.

whole year. The simplest is to maintain in Bering Sea an ice breaker of the Admiral Ermak type—an easy task, as the ice is not as thick and solid in Bering Sea as in the northern Russian ports. The second project is to build a railroad from Cook Inlet or Prince William Sound



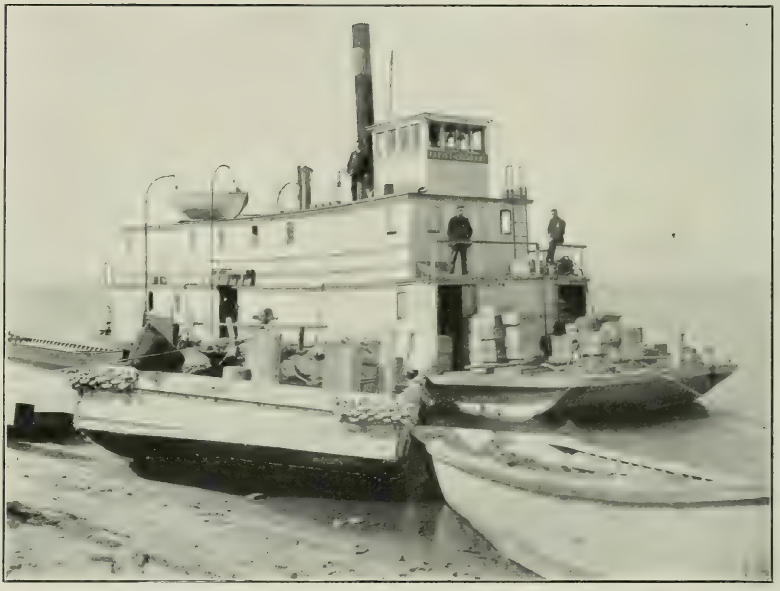
COUNCIL CITY AND THE FLAT NIUKLUK VALLEY, LOOKING TOWARD THE SEA.

on open Pacific waters to Nome by way of St. Michaels. The third plan is to connect Nome by railroad with the lower Yukon River, and ultimately effect a junction with the railroad from Valdez to Eagle. To complete this project would require about 900 miles of track.

The gold yield of the Nome region has hitherto come from the sea beaches and from gulches and beaches at most 10 miles from water transportation. Even 10 miles has proved almost prohibitive. In winter the placers are not worked and the camps are closed. No advantage can therefore be taken of the smooth snow and ice roads. In summer the tundra is two or three feet of mud, with a bottom of frozen ground. The services of teams are worth from $20 to $40 a day, and it takes a whole day to haul 1,500 pounds 10 miles. The lowest rate is three times as much as the minimum from Puget Sound to Nome, 2,700 miles, and twice as much as the rate from San Francisco or Puget Sound to Dawson. So prohibitive were the natural conditions that Mr. Chas. D. Lane, of the Wild Goose Company, considered it wise economy to devote 90 per cent. of the output of certain placer claims to a transportation system, thus reducing cost of exploitation for all future output to 10 per cent., rather than indefinitely to spend 90 per cent. of the yield for transportation alone. The Wild Goose Railroad, 7 miles long from Nome to Anvil Creek, earned its total first cost within 30 days of its opening and shows increasing earnings each year. From Council City, on the Niukluk River about 90 miles from Nome,

THE COUNCIL CITY WATER FRONT, LINED WITH FREIGHT BOATS.

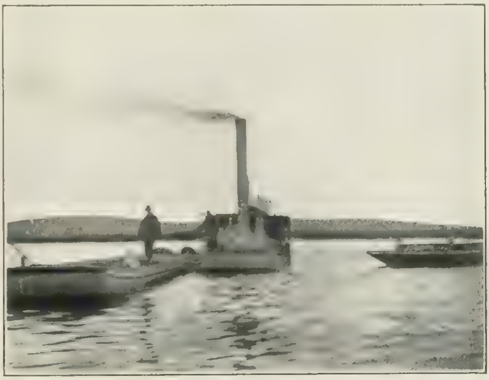
Mr. Lane has built a second road, also 7 miles long, connecting Council with Ophir Creek, and this road has also paid for itself in one season. Council is 55 miles from the nearest seaport, up a shallow winding river. That part of the Seward Peninsula on which Nome is located, a part about 5,000 miles in area, was geologically speaking, very recently an island. A deep indentation of the ocean runs 50 miles inland from Port Clarence, northwest of Nome, and Golofnin Bay, about 70 miles east of Nome, also extends many miles inland. These two bays are joined by a deep valley, so that 60 miles north and inland from Nome it is possible with one short portage to go from sea to sea. Council City lies in this depression, Ophir Creek and innumerable other rich creeks emptying into it from both sides. Gold has been found in paying quantities on nearly all of them, but it is impossible yet to develop them, owing solely to the cost of transportation. To develop one placer claim on Ophir Creek Mr. Lane not only built the seven-mile railroad, surveying it after it was finished, but he also put on from San Francisco to Golofnin Bay two schooners, one with auxiliary power; to connect with the schooners he built a shallow-draft stern wheeler and a number of steel barges, carrying 20 tons, which carry his supplies to White Mountain at the upper end of the delta of the Fish River. Here everything is for the second time unloaded, warehoused, and when water permits, transferred to very light wooden boats drawn



TOW BOAT, GOLOFNIN BAY. IT GOES OUT TO OCEAN STEAMERS AND TOWS LOADED BARGES UP THE FISH RIVER.

FLEET OF RIVER FREIGHT BOATS, ON THE FISH RIVER AT WHITE MOUNTAIN.

by horses, and carrying about 5 tons each. These boats are often dragged by main force over the gravel and sand bars between White Mountain and Council, 35 miles up the river. At Council everything is again transferred to a warehouse, reloaded onto the railroad, and carried to the end of the line, there again to be warehoused and ultimately carried by wagons over to the mining camp. To Council from Golofnin (55 miles) the freight rate by water is $40 a ton, and from Council to Ophir by the railroad (7 miles) also $40 a ton. The yield of one claim on Ophir Creek in one year has paid for the whole transportation, equipment, and operating cost from San Francisco to Ophir. Owing to the absence of transportation facilities nothing is being done further inland, but a railroad from the nearest port to the interior, a narrow-gauge railroad, should pay for its cost each season for many years to come. There are no heavy grades, no mountain work, and for many miles it runs through a heavily timbered country, but west of Council there is no timber and both lumber and fuel are exceedingly high in price. There is not only gold here, but also what gives promise of being one of the richest lead and silver districts in the world. Seventy miles inland from the ocean, up the Fish River and its tributary Omilak Creek, less than 50 miles by railroad survey, silver and lead ore has for 18 years past been quarried out, the ore running from 70 per cent. to 80 per cent. lead and about 120 ounces of silver to the ton. Much ore lies sacked on the dump, but in small quantities of several hundred tons it costs more to



AGROUND ON A SANDBAR.

FIRST PASSENGER TRAIN, WILD GOOSE RAILROAD.

move it than it is worth, although its smelting value exceeds $100 a ton. From Golofnin Bay there is a freight rate of $3 a ton to the Tacoma smelter, but the wagon haul to the river and the transportation down the river is as yet prohibitive. This one quarry, if properly equipped and opened, should yield a minimum of 10,000 tons a year, and it might grow to 100,000 tons.

For Pacific Coast maritime evolution Alaska has been of inestimable advantage. The Dawson rush of 1897 and 1898 impressed every available boat, and when it was over left well established lines with almost daily service. The Nome rush of 1900 again caused a demand for all available craft, and in summer the regular service keeps a fleet of more than a dozen ocean steamers busy. The Valdez developments even now justify weekly sailings. All the worn-out dilapidated craft of American register drift into these runs, and as the Alaskan coast is for the most part unchartered, unbuoyed, and unlighted, many of them find their graves in northern waters.

The export trade from Alaska for four months ending October 31. 1902, exceeded $20,000,000, and was equal to that from Hawaii (for ten months ending the same date), was three times that of the Philippines, and more than double that of Porto Rico. The island dependencies of the United States are densely populated, small in area, and fairly well developed. They are in the tropics and unfit for white men and their families. Alaska needs 10,000 miles of railroad, 20,000 miles of wagon roads and telephone lines, and can, as fast as transportation is available, give homes and employment to a population of 10,000,000.

# THE UTILISATION OF MOUNTAIN WATER POWERS.

### By Paul Letheule.

The development of the high mountain water powers of France and Switzerland affords most interesting and useful examples of pioneer work in a field which is rapidly growing in importance with the advance of practice in long-distance electrical transmission. The precedents—both mechanical and economic—to be found in the undertakings described in the following article are valuable in connection with current or prospective work in the Highlands of Scotland and the Pacific Coast of North America.—The Editors.

THE first *Congrès de la Houille Blanche* marked a new epoch in the electrical development of mountainous districts, its primary object being to facilitate the utilisation of the water power so plentiful in the Alpine districts of France. The accomplishment of this was naturally beset with obstacles, and the work of the Congress was, to a considerable extent, of legal character, as no step could be taken towards the realisation of the possibilities foreshadowed without first removing, by liberal legislation, the many difficulties presented by reason of the vested interests involved.

A TYPICAL ALPINE WATER POWER.

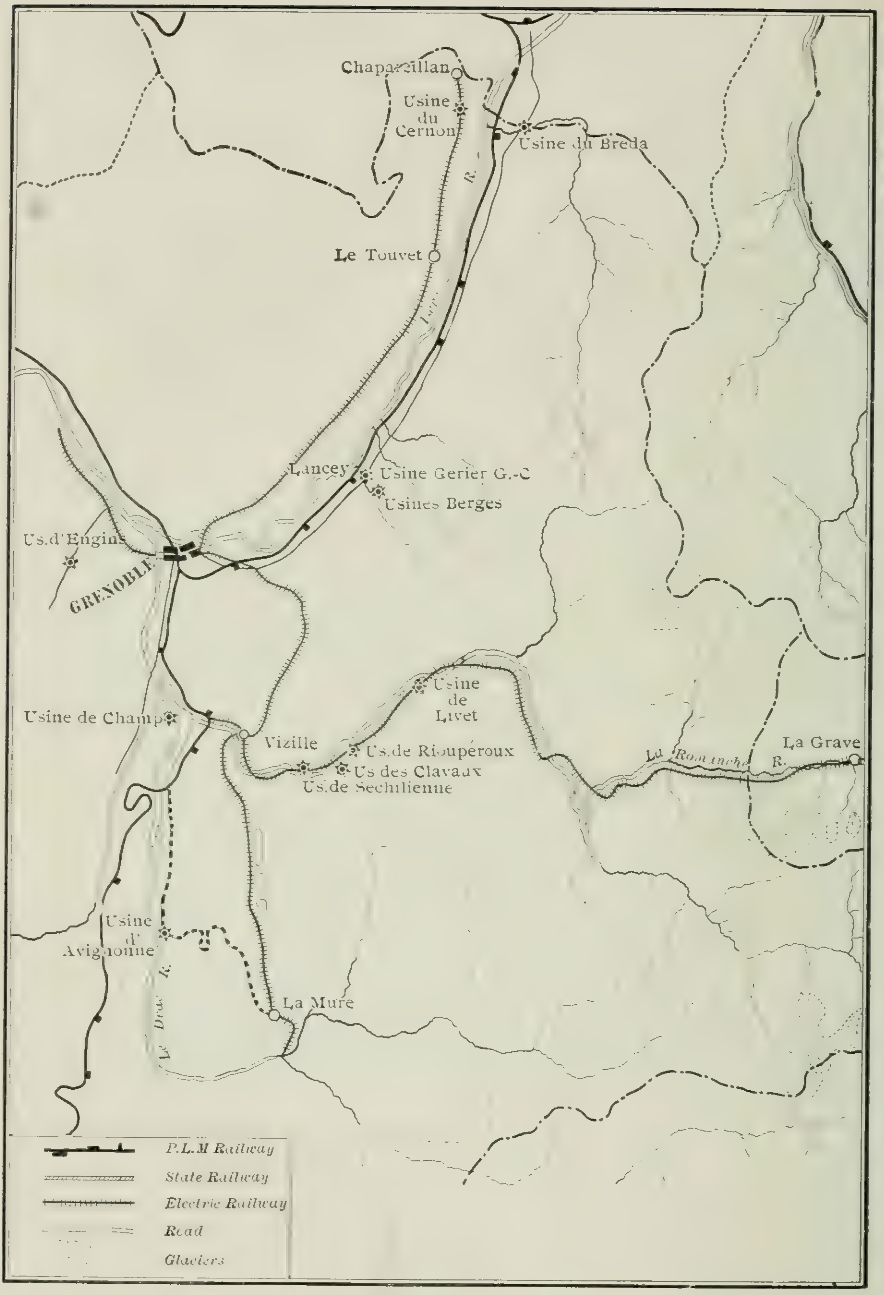
The legal considerations affecting the question, however important from a local standpoint, do not present a general interest, and are secondary in importance to the economic problems. The technical solution is not the least of the important factors which go to make a practical success of the possibilities. The mechanical and electrical features of an installation must naturally be taken into account when endeavoring to realise the best means of obtaining good economical results. This is especially true in that which concerns the harnessing of such variable sources of power as torrential rivers and mountain streams, like those found in such abundance in the Alpine districts of Europe. The mechanical installations by which they are successfully utilised, the effective solutions worked out for the problems of power generation and transmission, the costs of maintenance and operation, and the industrial development resulting, are of the widest possible interest and value in helping to determine the methods of obtaining the best results from enterprises of this nature elsewhere.

The best illustration of the economical, industrial, and technical aspects of the question can be given by briefly reviewing the characteristics of a few typical works of the kind.

A great variety of methods might be expected if we remember that the main installations utilise very widely varying heads and volumes of water-falls—volumes varying from 40,000 litres to 50 litres per second, and heads in some cases as low as 25 metres and in some as high as 620 metres. The common difficulty of all these installations is that due to the great quantity of débris carried by the stream; the greatest care has to be given to the intake, settling chamber, and conduits. Another characteristic of all but a few of these streams is the absence of any natural or artificial reservoirs for storing the water and modifying the irregularities of the flow, which are, for all these rivers, very large. None the less interesting, though exceptional, are the artificial reservoirs in existence or of which the construction is planned.

SUBTERRANEAN SOURCE OF A FRENCH ALPINE STREAM.

Most variable conditions are thus met with in the harnessing of the water powers of this region, and naturally modes of utilisation are



MAP OF THE DISTRICT ABOUT GRENOBLE, WITH ITS WATER POWERS.
The small towns and villages are omitted.

sought permitting similar variation in respect to the amount of energy which can be profitably consumed. Among the most promising applications in this particular is to be cited the electro-chemical, which is excellently suited to the irregular character of the water power available; but this has been seriously handicapped by the keen competition in calcium carbide production and other industries from more recent installations in foreign countries, so that the market value of those products has become insufficient for a remunerative business.

Light and power are delivered in great profusion to districts which unfortunately do not present a large centralisation of population and industries. Workshop and home industries may offer interesting developments in connection with the distribution of cheap energy, and as an interesting instance might be cited the use of hundreds of sewing machines, run electrically at the cost per day of 10 centimes per machine.

Larger customers for power are usually paper makers, wood sawers, oil makers, tile makers, printers, etc. In the field of traction belong a few original mountain railroads or tramways, which deserve a more than passing notice. Much progress however remains to be achieved in the way of utilisation of energy, but in this as in many other cases, the first step made in the aid of development of local industries was to equip the available power, and then to discover outlets for the energy.

The rendezvous of the Congress was in Grenoble, a city of about 70,000 inhabitants, near the junction of the river Isère and its tributary the Drac, two copious streams, capricious at all times, the latter of which has on several occasions threatened destruction* and partial devastation to the now flourishing and industrial city which obtains a new source of life from these unruly torrential streams. The industries which are part and parcel of the life and success of this city are more or less tributary to the constant output of energy now derived from the waterfalls. These are the cement industry, the glove factory and dependencies, with a yearly production of 40,000,000 pairs; leather dressing and tanning, skin and fur dying, the furriers' trade, the manufacture of buttons and clasps, distilling, hat making, and wood working. Great supply of power is available within easy reach of the city, so well situated at the junction of two rivers which offer, or whose tributaries offer, a number of well equipped waterfalls. South of Grenoble is the Drac valley; southeast, the Romanche valley; north, the valley of the Isère.

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* A complete devastation took place in the Middle Ages.

The valley of the Drac river and its tributary the Romanche affords typical power-producing centres, the most interesting of which it is proposed to review below. It is to be remarked that the two main waterfalls on the Drac river are of quite different character and have nothing in common. Both are so interesting that it is necessary to devote a description to each. Of the water powers on the Romanche river, which have all been devoted to the electro-chemical industry, some have failed to prove remunerative, and special attention will be given to the critical condition which they are in and the features appertaining thereto, especially in the case of the most powerful and best equipped. The Livet station, which is in every sense a typical Alpine hydraulic plant, and which lately abandoned the electro-chemical industries to devote itself only to power and lighting distribution, has achieved by this means an apparent success.

A CHARACTERISTIC VALLEY STREAM AND VILLAGE IN THE FRENCH ALPS.

The Isère valley is characterised by power installations with a high head of water, which seem to be most typical of the idea attached to the designation "*Houille Blanche.*" Small streams falling down in precipitous and picturesque cascades, rocky mountains cov-

THE "WHITE COAL" OF FRANCE AND SWITZERLAND.

ered with vegetation and large forest domains, lofty steel conduits climbing the hills in a nearly vertical ascent, as seen in background on page 681—such are the conditions prevailing in the watershed of the Isère, where the falls are often 500 to 600 metres high, and where as much as 1,700 metres head will ultimately be used by means of three power stations at Lancey.

From this renowned spot, which was the very cradle of the art of water-power installation in France, and which is situated about 15 kilometres northeast of Grenoble, on the river Isère, were started the excursions of the different parties attending the *Congrès de la Houille Blanche.* We will not concern ourselves with following the very leisurely programme which was pleasantly accomplished in the time at their disposal, but confine ourselves to the above outlined programme of inspection and examine successively the main characteristics pertaining to the power installations of the three definite valleys already described in the following order: Isère, Drac, and Romanche.

The first of the high falls of the Isère valley, both in order of installation and in interest, are those of Lancey, the first and until very recently the highest* of their class ever equipped. The mention of these falls would be incomplete without the name of Aristide Berges, who identified himself with these works from the very start, and who with the help of his sons is pushing them to their full development.† The natural conditions prevailing in this privileged locality were all particularly favourable to the realisation of M. Berges' schemes. Lancey is a low valley encircled by the very steep slopes of the Belledone mountains, of the average height of 2,500 to 3,000 metres, covered with high forests which prevent the range being denuded by torrential streams.

First among the latter the Combe torrent was used for operating the Berges paper factory, which is run entirely by mechanical power from the waterfalls. Its power plant includes 12 turbines of an aggregate of 4,000 to 5,000 horse power. Its annual production of paper exceeds 10,000 tons; of pulp, 3,500 tons, and of cellulose, 4,000 tons. To this first installation using the power at Lancey were added a lighting and traction plant which will be dealt with later.

As early as 1868 the first conduit for bringing water to the paper factory was installed at Lancey with water from the Combe stream under a head of 200 metres. The volume of water amounted to 500 litres. To this first fall were added a few years later the waters available from two small streams derived from the same Belledone mountains, with the resultant volume of 500 litres per second under a head of 500 metres. All has been working without a hitch, and the promoter, M. Berges, states that no difficulty of any sort has been experienced from the high head of water. The conduits have proved resistant to oxidation, and their performance has led to the hope that they will last a whole century, whether placed in the open air or underground. Coal-tar paint mixed with carbon sulphide offers a sufficient protection. Joints and corner pieces have shown good resistance to the pressure due to 500-metres fall. Outlet pieces of hard bronze or aluminium last a sufficient time, and the same remark applies to the various valves or gates. The turbines themselves are easy to build and to operate and show as good an efficiency as with average heads. The greatest difficulty experienced is in respect to the volume, which shows a relative variation of range from one to ten at Lancey.

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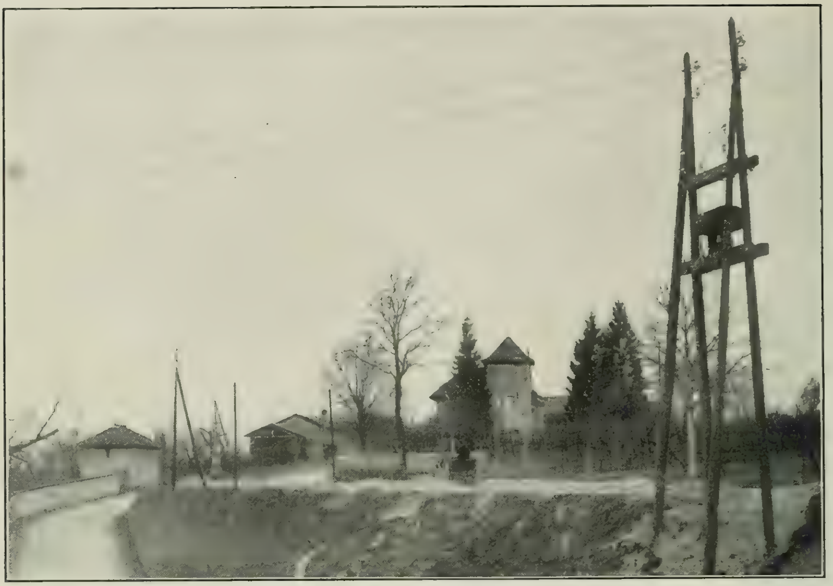
* The fall of 620 metres, above mentioned, up to recently held the distinction of being the highest fall ever equipped, a record which has lately been eclipsed by a Swiss waterfall, which unfortunately cannot be described here.

† He is the originator of the picturesque and expressive term "Houille Blanche."

M. Berges has proceeded with very far-reaching views and with very scientific methods to the regulation of the flow—a regulation which is already secured in part by the construction of a retaining dam at the outlet of a lake situated on the Belledone mountain, and which will be completed by the interconnections of similar lakes and the installations of new power stations fed from these lakes. The average amount of power thus assured for the whole year round, on that small basin of 44 kilometres area, is estimated to be 10,000 horse power regularly, from three power stations, the first one now in existence and using the first waters mentioned. The first station utilises two falls of a total 500-metres head and 500-litres volume; the second station, a fall of 527-metres head and 500-litres volume; the third station, a fall of 514-metres with a volume of 800 litres. The first station is now sufficient for the paper factory, as well as the lighting and tramway service in their present states.

LANCEY POWER PLANT, VALLEY OF THE ISERE; BELLEDONE MOUNTAIN IN THE BACKGROUND.

The paper factory uses mostly mechanical energy, from 12 turbines aggregating 4,000 to 5,000 horse power, applied to driving saws, wood grinders, elevators, etc., which are operated by mechanical transmission from the shaft of the turbines. These latter are moved by



10,000 VOLT TRANSMISSION LINE AND 3-KILOWATT TRANSFORMER ON THE POLES, VALLEY OF GRÉSIVAUDAN.

the action of water jets, 20 millimetres in diameter, at the periphery of the wheel. Four of these small jets are sufficient for a 600-horse-power turbine.

By reason of the high speed of the water, reaching to about 60 metres per second,[*] the peripheral speed of these turbines is very high. Thus they affect the form of a narrow wheel of large diameter, the 600-horse-power type measuring 4 metres in diameter, and 5 centimetres only in thickness. To the paper factory is added a continuous-current generating set for production of hypochlorite, used for bleaching the pulp.

The lighting station is intended to generate electric current for a lighting distribution extending a radius of 15 kilometres in length in the Grésivaudan valley. The building and the mechanical installation are similar to those of the plant just described. The following are the characteristic features of the whole of the installation:

Four single-phase alternators feed the high-tension line by means of oil-insulated step-up transformers. The line voltage is 10,000, the frequency 50 cycles. Great economy has been combined with sufficient safety in the construction of the cross-country high-tension lines, which have a total length of about 50 kilometres. The engraving opposite shows the wooden pole construction used throughout, as well as the special arrangement supporting the line transformers stepping down the voltage for 120-volt distribution circuits. These line transformers are paraffine insulated, like the station transformers, and fitted with a protecting cap, as shown in the picture.

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[*] The theoretical speed $\sqrt{2gh} = \sqrt{2 \times 9.81 \times 500}$ = about 100 metres. The turbine peripheral speed amounts to 65 per cent. of this figure.

The lighting charges are so low that the incandescent electric lamp is in general use even at the remotest farms. One of them, for instance, visited at random, uses one 10-candle-power lamp at a charge of 25 francs per year, a second lamp at an additional charge of 15 francs, and three 5-candle-power lamps at a charge of 15 francs total —altogether 55 francs for 35 candle power, or 1.6 francs (32 cents, or 16d.) per candle power per year.

The tramway generating station installed at Lancey is owned by the *Compagnie du Tramway de Grenoble à Chapareillan*, and is operated on the three-wire system. The company do not own the falls, but buy the water power from M. Berges for their machines situated near the paper factory, paying 100 francs per horse power year, with a minimum guaranteed consumption of 25,000 francs a year, which corresponds to an average continuous load of 250 horse power. The average load is lower, but the maximum sometimes reaches 1,000 to 1,500 horse power. The only line operated connects Grenoble (70,000 inhabitants) with Chapareillan (2,200) a distance of 43 kilometres, thirty-ton trains with a half-hour schedule being run in the suburbs of Grenoble and one-hour schedule on the country line.

The voltage drop and distribution losses due to the great length of the line are still more greatly emphasised by the nature of the profile and the distance from the generating station, which is three kilometres distant from the nearest point of the line. These losses would have been prohibitive with an ordinary 600-volt distribution, or would then have necessitated the use of several generating stations. Preference has been given to the three-wire system which was adopted for the first time at this locality and which has had very few imitators since. The current is carried to the cars by a three-wire system with two overhead conductors used as outside wires with 1,200 volts difference of potential, and the track rails as a neutral with 600 volts difference of potential to each of the overhead wires. The current is received by two series-wound motors connected in series, their common point being used as a neutral and their outside terminals being connected with the two overhead trolleys of the car. Yet in spite of this arrangement the voltage drop is relatively large in the feeder circuit of the tramway. This is composed of three feeders with areas of 64, 125, and 90 square millimetres, and voltage drop of 250, 150, and 400 volts respectively, boosted up at the generating station, electric booster sets, each composed of one motor and two generators, boosting symmetrically the two wires of the feeder. The motor is run from 1,200-volt bus bars. The track is crown bonded and connected to the neutral bus bar of the switchboard by a conductor of 125-square-millimetres section.

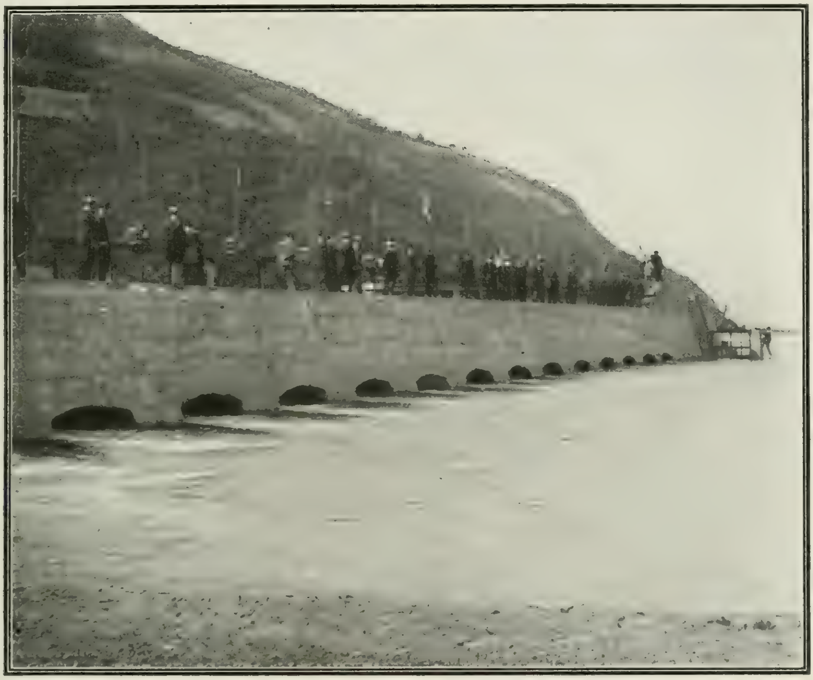
Drac Valley.—Of a very different character is the Drac river, which is estimated as capable of rendering 100,000 horse power in the Department of the Isère alone.

The first installation to be mentioned is the Fure & Morge plant at Champ, near the junction of the Drac and Romanche rivers, 15 kilometres distant from Grenoble. This plant is exclusively for the distribution of power. The second installation is up stream from Champ, on the Drac river, near Avignonet, but the local conditions are so different at these two stations that very different arrangements have been adopted.

The flow of this capricious river may vary from 20 to 1,200 cubic metres with a violence which is not tempered by any obstacle whatever to its mad rush, as there are no forests along its valley. The Drac at Champ presents the aspect of a shallow river, the width of which, in high water, may exceed 1 kilometre, and would expand still further if it were attempted to confine it by a large dam. The same river is cramped up at Avignonet into a very narrow neck, eminently disposed for the construction of a solid retaining dam.

The water has been taken from the Drac at Champ by means of a low dam in the bed of the river, a dam which is constantly under the river level, but yet is sufficient to create a current of water from a side outlet of a width of 16 metres, bordering a long intake provided with gratings, in the form of light shutters, preventing the ingress of stone and rubbish, of which the river carries a great deal. The river current passing alongside of the intake shutters favours the discharge of gravel and stones through the outlet. What passes the shutters enters the settling basin, which has a surface of 3,000 square metres, and in which the water settles before entering the flume.

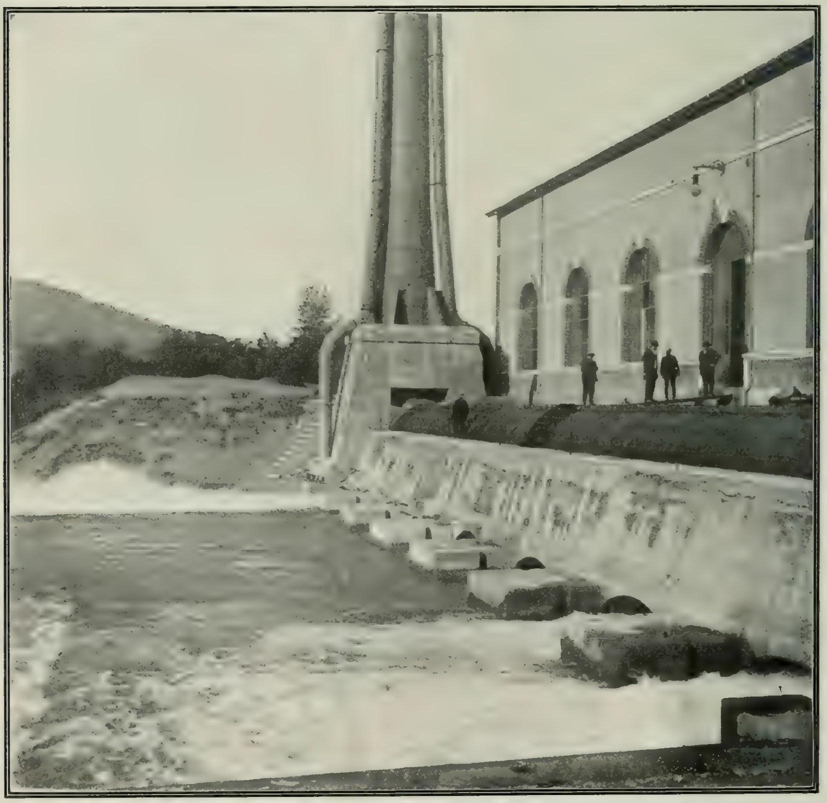
This flume, built in the gravel and earth and lined with hydraulic cement, varies in width from 60 metres to 22 metres and in depth from 1.50 to 4 metres, and runs a length of 600 metres with a maximum slope of 4 millimetres per metre. It ends in a second settling basin provided with sufficient discharge drains. This basin is built with two parts separated by a dividing wall, the first part for sedimentation, the second for supplying the conduit. This opens about 2.70 metres under the level of water in the charging chamber, and the admission of water to the conduit is controlled by gates arranged, not directly on the conduit, but at the entrance of the second chamber, so that a sudden emptying of the conduit will not result in vacuum effect, but in admission of air to the conduit pipe.



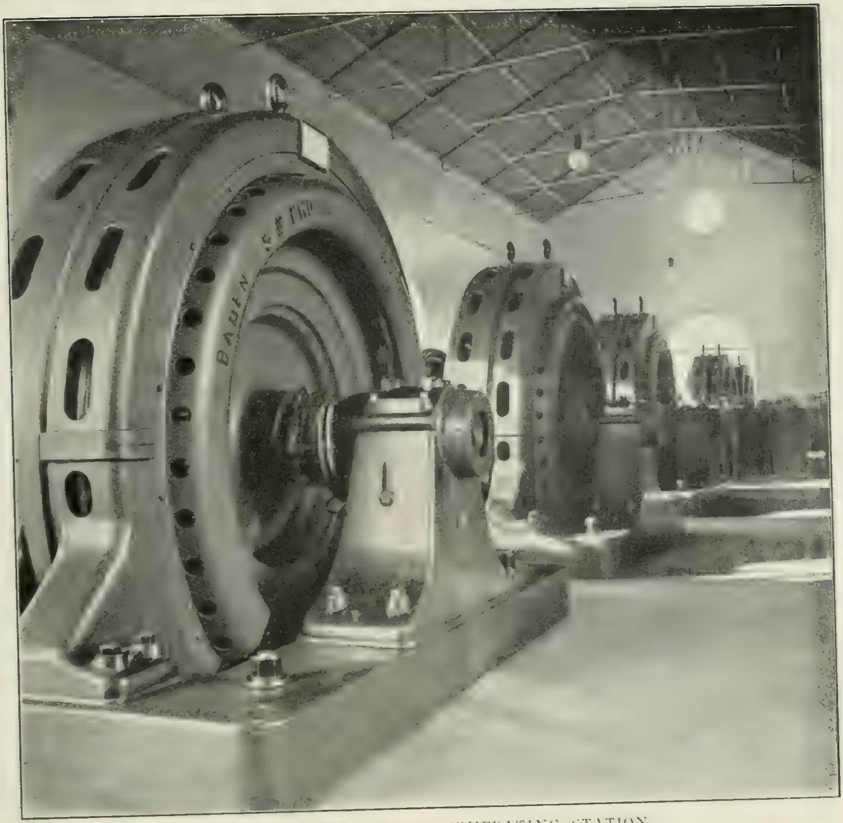
HEADWORKS ON THE DRAC RIVER.

Of the 4,600 metres of conduit, 3.3 metres diameter, 2,100 metres are reinforced concrete, and 2,500 metres steel. The concrete part of the conduit is used for supporting pressure up to 20 metres depth of water, its total thickness being 0.020 to 0.025 metres. A network of circumferential and longitudinal rods is embedded in the cement, the circumferential rods having a thickness of section varying from 11 to 22.5 millimetres and the longitudinal rods sections varying from 6 to 12 millimetres. The reinforced concrete conduit rests on a bed of concrete with a thickness of 0.3 metres and is buried in the earth to a depth of 2 metres. The steel conduit, 2,500 metres long, is similarly embedded and also placed on concrete supports, a practice which is quite uncommon, but presents many advantages in connection with large sectional conduits. The conduit is made of sheet steel from 7 to 15 millimetres thick. In this mode of construction and arrangement no expansion or deformation need be feared, nor any injury from impact or water hammer, although this conduit contains the immense mass of 40,000 cubic metres of water running at a speed of 2 metres per second. As a precaution against impact, three air chimneys or shafts have been specially disposed on the length of the conduit, a precaution which is often used here for impact protection. An unusual precaution, additional in this case, is the use of compensation gates, which will be again referred to in the description of the generating station. Below is an outside view of the station showing the vertical shaft tube.

The Champ generating station is a well lighted two-story building set on substantial concrete foundations. The connecting cables and transformers are placed in an underground chamber, well ventilated and provided with a 10-ton crane and track connecting with a repair



DOWNSTREAM SIDE OF THE CHAMP STATION, SHOWING TAIL RACE AND OPEN AIR SHAFT.



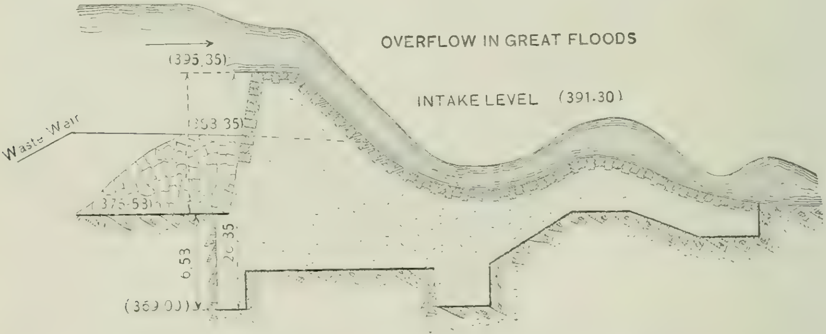
DYNAMO ROOM, CHAMP GENERATING STATION.

shop forming part of the station. Oil-bath type of transformers are used, cooled by water under pressure.

The ground floor contains the dynamo room, 44 metres long and 12 metres wide, provided with a 15-ton crane. The first floor contains the switchboard and arresters and also the engineer's apartments. The main generating groups are composed of 1,350-horse-power Brenier turbines coupled with three-phase alternators, running at 300 revolutions per minute. The couplings are the elastic rubber type, as generally used in hydraulic plants on the continent, but the rubber, in variance from common practice, does not work with expansion but by compression. Besides the main machines, the station includes two 150-horse-power exciting sets and a 5-horse-power turbine for feeding the water accumulator used for regulation.

Regulation of the main group is made by means of hydraulic servo-motors operating the admission distributor of each turbine and the compensating valve shunting the turbine. This couple of gates is designed for a constant admission of 4 cubic metres of water, which flows entirely through the turbine at full load, and in part through the compensating arm at fractional loads. The flow of water is therefore regular and free from any inertia effects likely to result from the quick action of the turbine regulators.

The 1,350-horse-power alternators are rated for this output with 80 per cent. power factor. They are of the Brown-Boveri revolving-field type, wound for 3,000 volts. Step-up transformers are of the Brown-Boveri three-phase type, each rated for 1,150 kilowatts; their principal features consist in the oil bath and the water circulation, and double secondary voltage. This latter possibility has been arranged for as a preliminary precaution against eventual difficulties liable to be met with in operation at 26,000 volts. The contemplated voltage of 26,000 volts is obtained from these transformers with the windings star connected, and the delta connections derived at the switchboard will give 15,000 volts.



DAM ON THE DRAC NEAR AVIGNONET. FIGURES ARE ELEVATION IN METRES ABOVE SEA LEVEL.

No difficulty whatever has been experienced in the station and line operation, which have been in regular service since March 15, 1902, under 26,000 volts. Regular distribution of power has since that date been made to fifty-seven works, exclusively for motive-power purposes.

The main high-tension line is supported by poles common to this and another company, operating at 26,000 volts, a condition seldom met with. The common line has a length of 36 kilometres. Secondary derivations of the line made by this company are made of 6, 5, and 4 millimetre wires supported by wooden poles by means of blue-glass insulators of American manufacture, tested at 80,000 volts. Horn arresters with liquid resistances are used throughout. Sectional switches are similarly provided with horn projections. The 26,000 volt current is received in eleven transformer stations feeding the distributing network at 1,000 and 2,000 volts.

The following data of conditions of station and line operation and costs, as well as of the actual status of affairs, have been obtained through the kindness of the director, M. Lépine:

The minimum available flow of water measures 17 cubic metres per second, the total head 37.40 metres, reduced to an effective head of 32 metres by losses in the gratings, canals, and conduits. Thus the minimum hydraulic power in kilogrammetres per second is $17{,}000 \times 32 = 544{,}000$.

| | |
|---|---|
| Actual efficiency of turbines........................ | =0.76 |
| ” ” ” alternators.................... | 0.94 |
| ” ” ” transformers.................. | 0.975 |
| ” ” ” main line.............. ...... | 0.94 |
| ” ” ” secondary line and transformers.. | 0.90 |
| Total efficiency.................................. | 0.58 |

Actual effective power available on the secondary network, 3,160 kilogrammetres per second, or 4,176 horse power. Each horse power year is actually sold at 125 francs for a 12-hour-day load and 150 francs for a 24-hour-day load.

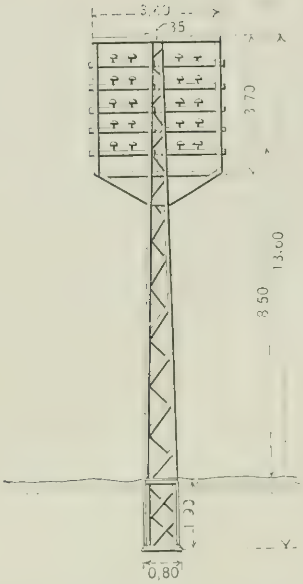
3,300 horse power are now contracted for, for a period of thirty years, at the expiration of which the contracting parties will own the installation. This arrangement is a very original one, and it has since found some imitators, at least in one French installation of the same sort, dealing mostly with municipal lighting or municipal contracts for private or public lighting and power.

Avignonet Station.—The Avignonet station is exposed to the same variations of flow and to the same difficulties in respect to the suspended matter and gravel carried downstream by the force of the flow; but here the small width of the Drac has permitted the construction of a high retaining dam, which is one of the most distinguishing features of the hydraulic plant (page 688). This dam is 20 metres high, with a thickness of 24 metres at the base, and 4.75 metres at the top, and concrete foundations 7 metres in depth. The parts of the dam exposed to erosion are rock-faced.

The dam is so high that it is overtopped only in time of great floods. Most of the water flowing in the stream above in ordinary stages is carried by the flume, which is 840 metres long and has a capacity of 39 cubic metres per second. It is built underground as a protection against injury by landslides or falls of rock. A spillway with movable weirs is provided at one side.

At the end of this short canal and before the water enters the penstock, there is a settling basin. The penstock leading to the generating station is 2.2 metres in diameter, and the same general features characterise its construction as in preceding installations.

The generating station contains seven generating units, three-phase Creusot alternators direct coupled to turbines of 1,750 horse power. The frequency and terminal voltage of the machines is the same as in the preceding installations, and part of the high-tension line is common to the Fure & Morge Company, as before stated.



HIGH TENSION LINE AND POLE, CHAMP AND AVIGNONET PLANTS.

The main characteristic of the alternators installed here is the direct winding for 26,000 volts, which is a very exceptional voltage for a generator without step-up transformers.

High-Tension Line.—A preceding paragraph referred to the line of this plant. The accompanying figure illustrates its construction. One side of the pole shown is reserved to the Avignonet installation and the other to the Champ plant. Inter-connection and sectional switches are disposed at various places, together with lightning arresters for protection against atmospheric discharges. The arrangement of the lines promotes the facility of repairs, as one side may be grounded for a time, when needing repairs, while the other side is utilised temporarily. Incidentally it may be mentioned that these metallic poles are more expensive than the ordinary wooden erections. The pole above described costs, completely installed, 500 francs.

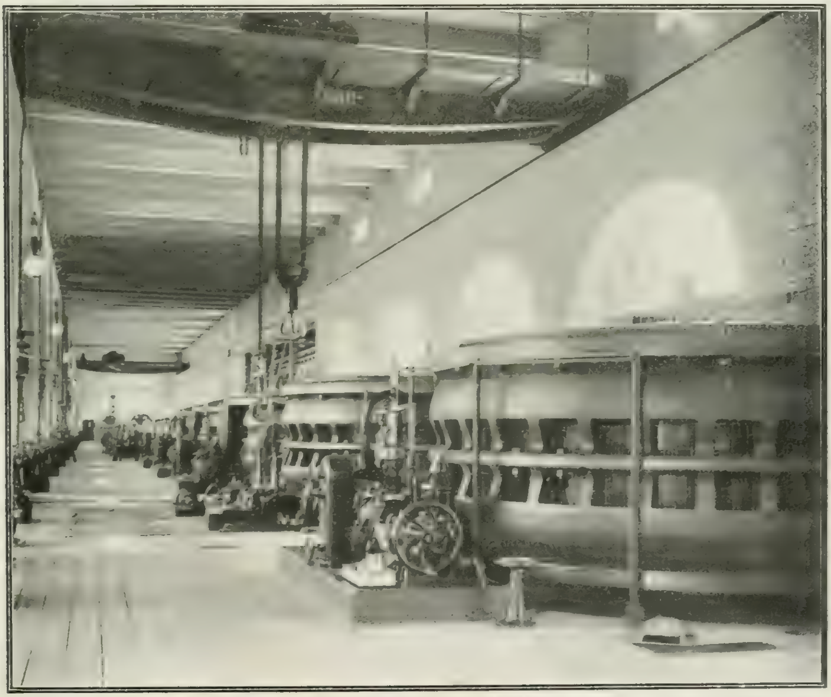
This plant is unlike that at Champ, which generates current only for lighting and power. The principal customers are *La Compagnie des Mines de la Mure,* the *Cie des Tramways de Grenoble, au Villard,* and several manufacturers of Bourgoin which is situated at a distance of about 100 kilometres from the generating station. The prices are about the same as those before quoted, and the operation has been very successful, in spite of the high voltage directly generated.

Romanche Valley.—Further up-stream on the Romanche river from its junction with the Drac, which point of junction is occupied by the Champ installation above described, are a number of interesting works which have made a rich and prosperous district out of this once poor and desolate valley, or at least were doing so until the carbide crisis put a limit on this increasing prosperity. In a length of 20 kilometres along this valley are to be found no less than six plants, aggregating from 30,000 to 40,000 horse power, destined for the utilisation of power for mechanical, electrical, or electrochemical purposes. The following are among the most notable:

Sechilienne plant, generating energy for the calcium carbide industry.

Chavaux, which supplies power for the same purposes and also for electrolytic processes in the manufacture of sodium and sodium chlorates.

Vizille and Riouperoux, for mechanical drive of paper factories, these latter using two falls, 35 and 40 metres in height, through eight turbines with an aggregate power of 7,000 to 8,000 horse power.



DIRECT CONNECTED GENERATORS ON TOP OF THE TURBINE SHAFTS. REGULATING AND CONTROLLING MECHANISM IN THE FOREGROUND.

Livet Station.—A short distance up-stream is the Livet station which is very interesting in its hydraulic features. The station was built for the calcium-carbide industry, and is now undergoing changes to enable the supply of energy for light and power to the town of Grenoble, 35 kilometres distant. In addition to points common to other stations already mentioned, this displays certain features due to its well-known designer, M. Drouhin. He sums up thus the difficulties to be met and the precautions he would recommend:

HIGH-TENSION SWITCHBOARD AND LIGHTNING ARRESTERS.

1. The avoidance of an embarrassing deposit and accumulation of gravel, silt, etc., in the stream.

2. The reduction of the speed of flow of the water entering the settling basin so that it may deposit there, rather than in the flume beyond, its suspended matter.

3. The removal of the floating débris in the flume and the admitted surface waters.

4. The construction of the dam to resist the sudden and violent floods to which the rivers are subject.

5. The protection of the toe of the dam against wash and undercutting.

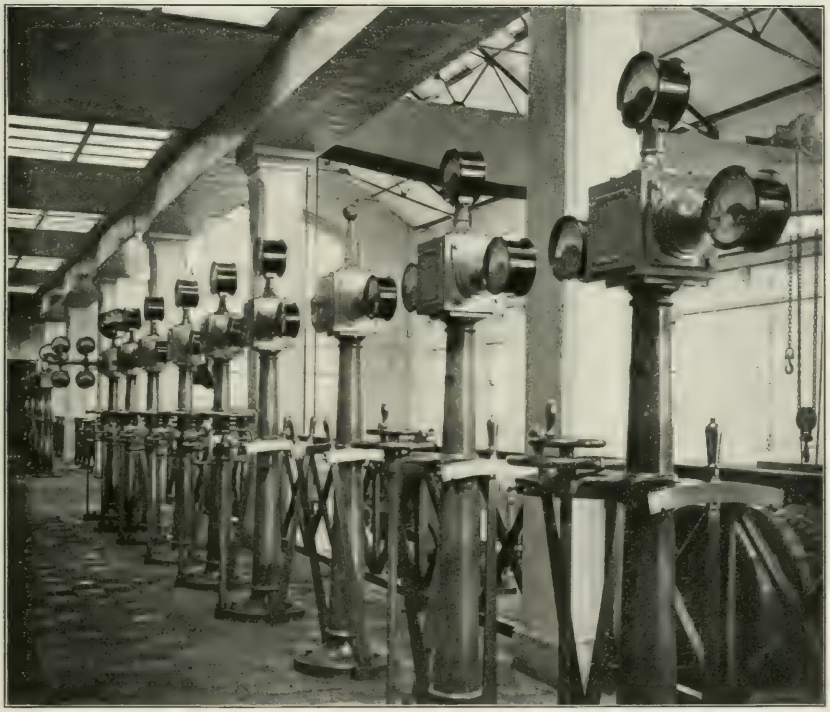
6. The protection of the canal and flume against damage by fall-

ing rocks, landslides, or similar accidents and the arrangement of the canal with such a slope as to allow the deposit of suspended matter.

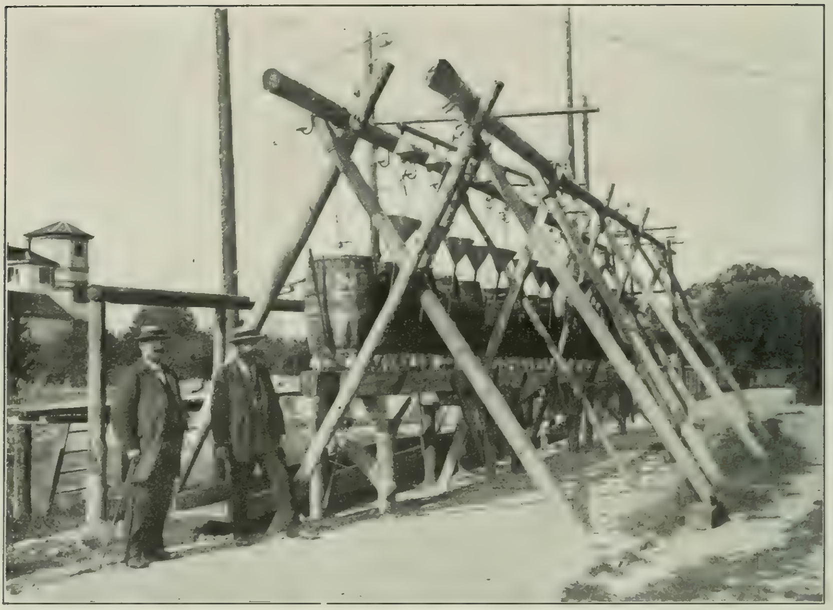
7. The arrangement of matters so that in case of accident at the generating station the turbines could be shut off without injury to the penstock and without emptying the flume.

8. The protection of the flume and penstock against the effects of sudden overflow and against the danger of being pierced by falling rocks.

Piling in the bed of the river below the dam may be used to prevent cutting by the falling water and the gravel and stone it carries. The intake is best placed at least two metres above the bottom, to escape the suspended matter carried along the bottom; floating débris may be removed by suitably disposed gratings. The first settling chamber should have a capacity equal to at least fifteen times the volume of flow per minute at the intake gate. It should be convenient of access and provided with drains for emptying and flushing it. There should be several settling chambers along the hydraulic canal to permit the subsidence of as much as possible of the silt. In no case



INDICATING AND REGULATING MECHANISM FOR HYDRO-ELECTRIC GENERATING STATION.



TEMPORARY RIGGING FOR HIGH-TENSION WORK.

should the speed of flow through the canal exceed 2 metres per second. Underground construction is advisable in many Alpine districts as a protection against destruction by landslides or avalanches.

The station equipment at Livet includes five generating sets of 1,250 horse power at 350 revolutions per minute, carbide type of alternators, 70 volts, 46.6 cycles, Thury system. New sets will be installed for the supply of current to Grenoble, with the understanding that the owners of the plant put up the transmission line, transformer stations, and secondary network at their own expense and risk, the city agreeing to pay them a yearly subsidy of about 100,000 francs for 45 years. They have further the exclusive right of power distribution in the city with a guarantee of the consumption of a minimum of 1,400,000 kilowatts yearly at the following prices:—for lighting, 0.12 franc per kilowatt for the first 1,000,000 kilowatts, and 0.06 franc per kilowatt for all above the first 1,000,000; for power, 0.03 franc per kilowatt. On yearly contract, the price per horse power per year is to be not more than 120 francs nor less than 70 francs.

The minimum power consumption guaranteed by the city is based upon the expected abandonment of municipal gas lighting and water distribution, and will in all probability be largely exceeded and additional demand be made upon the capacity of the small Engins station.

# FOUNDRY MANAGEMENT IN THE NEW CENTURY.

*By Robert Buchanan.*

### III.—MOULDING BY HAND AND BY MACHINE.

Mr. Buchanan's first article appeared in our issue for December and dealt with the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant. His second paper discussed crane service for the foundry floor. The next will take up the purchase of supplies.—The Editors.

OF the total castings made in foundries at least three-fourths are made in moulding boxes, or, to use the American term, flasks. The number and fitness of the available moulding boxes is thus a matter of the greatest importance,

Foundries in many cases have their stock of moulding boxes neither large nor fit, and it is the one with good boxes sufficient in number which survives when the stress comes of dull trade and low prices. In some foundries a box part is considered past use only when it has become dangerous to use, or has dropped out about three times in one day. If it drops out only ocasionally it is not considered as being anything worse than not just so good as it ought to be. It would be well if moulding boxes of doubtful character were made to be a credit and profit to their owners by being re-melted and cast into ones which will not drop out.

Seeing that moulding boxes are a necessity, it is the foundryman's duty to provide these in such numbers and with some such system as will obviate any waiting by his men or delay in the execution of orders. How to do that without tying up too much capital in the plant is what I shall now consider.

Where the greater number of patterns are bedded in the floor, there the moulding boxes may be least in number. To make moulds well by the system of "bedding in" of patterns requires, on the whole, a higher measure of skill on the part of the moulder than does the "turning over" or "rolling over" of complete moulding boxes. Such higher skill has to be paid for in most cases, and in addition, bedding in a pattern will, with only a few exceptions, take longer to do than turning or rolling over. We thus get back to the old question of time to be paid for or tools to be provided.

In planning the moulding boxes to do jobbing castings, or work

A PART OF THE LOAM DEPARTMENT, FOUNDRY OF THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

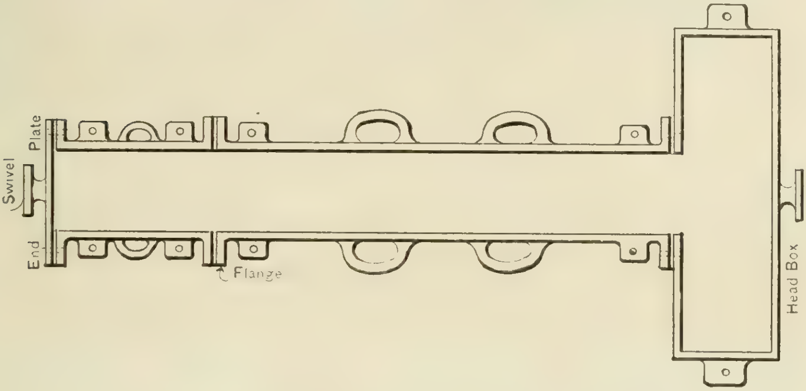
which is not of a repeat character, a system of interchange of parts is valuable, giving as it does a full service with a minimum of outlay. This interchange of parts may be made available for box parts made in sections, or for box parts cast all in one. To obtain the full advantage of interchange of parts the holes in the snugs, whether for fixing the guide pins or for the pin passing through, ought to be bored to templates. It is as easy to bore the holes in the correct position as otherwise; it only requires a little more care and precision. The exceptions in which cast holes may be used will be exemplified later on.

To shew the system of interchange let us take a set of moulding boxes suited to make pipes or columns in 9-feet lengths or odd lengths longer or shorter than that. Make the pattern of the moulding box so that it will cast to 10 feet long. Cast two tops and two drags or bottom boxes, each having suitable bars as shown on the opposite page.

In addition to the two 10-feet lengths, pipes or columns over 20 feet long or down to 2 feet 3 inches inside the flanges, may be readily cast by casting from the same wood pattern one pair of boxes to each of the following sizes:

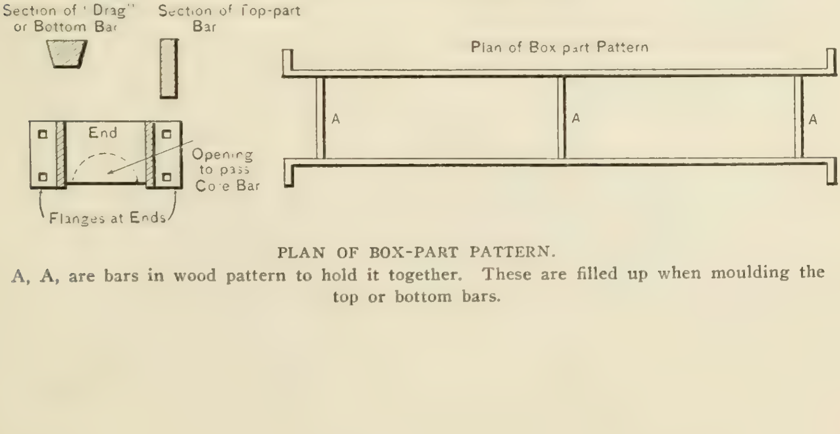
One pair moulding boxes 8 feet long, one pair 6 feet long, one pair 4 feet long, one pair 3 feet long, and one pair 2 feet long.

One flat top part and a few end plates and head boxes complete the outfit. It is well not to have the head boxes too narrow. Narrow head boxes save ramming, but are not suitable if brackets are wanted cast onto flanges. An easy fit in head boxes also allows the casting to contract freely without risk of pulling the flanges off. Another way in which sections may be made to do double duty is by making midparts in sections, the sides of the midpart being made to serve tops and drags of different breadths but the same length.



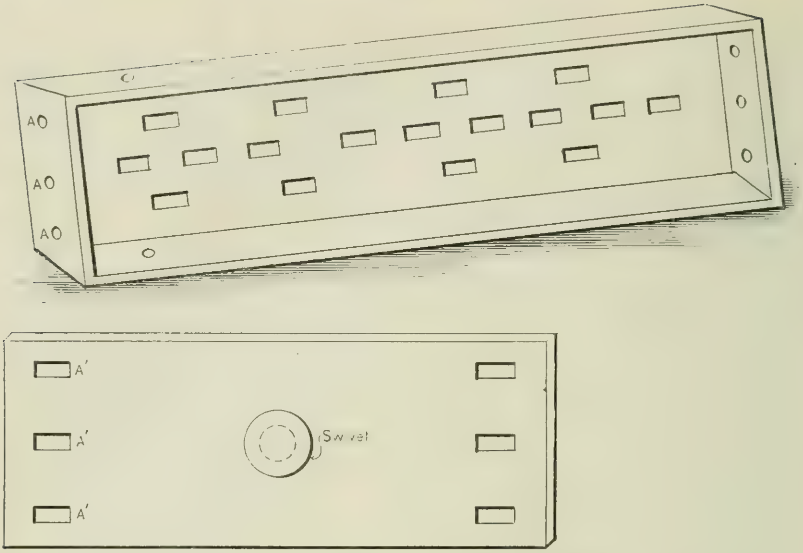
ADJUSTABLE FLASK FOR MOULDING PIPES OR COLUMNS.

If two sides, upper figure, page 698, be say 6 feet long, these will form sides for any size moulding box of which the length is 6 feet. Ends, separate, give the breadths required, the bolt holes being cast elongated as shewn to allow for adjustment in suiting the pins and pin holes of the top and drag if so required. If one has a range of moulding boxes consisting of tops and drags from 6 feet by 4 feet, every 6 inches up to 6 feet by 6 feet, by having ends of the different breadths one pair of sides is made to do for five sizes of midparts. There is the time spent in changing the ends to be considered, but this can be done



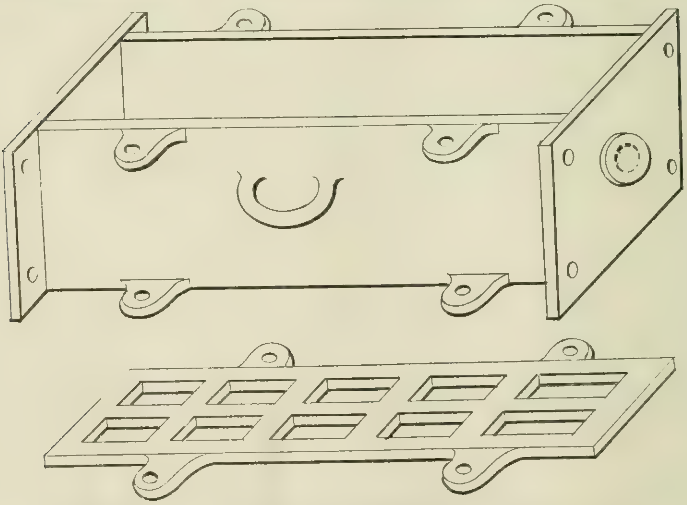
PLAN OF BOX-PART PATTERN.

**A, A, are bars in wood pattern to hold it together. These are filled up when moulding the top or bottom bars.**



SIDE AND END OF MIDPART MADE IN SECTIONS.

by an unskilled worker in a short time. The advantages are, less money in the plant and less yard room occupied by the boxes. The slots along the middle of the side help to lighten it and provide easy means of venting the mould itself or any cores in the vicinity of the slots. Vents of cores should not be on the joint of a mould if they can be got through the side. If bow handles are put on they ought to project



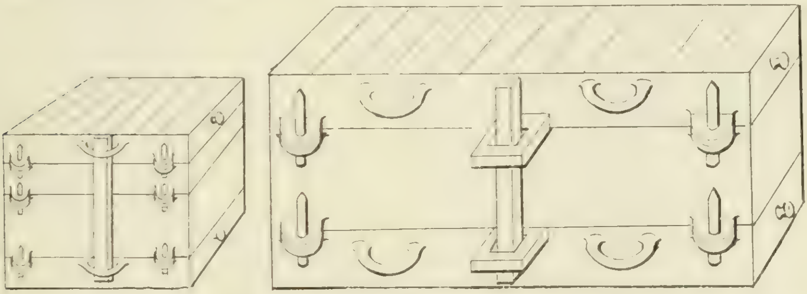
MIDPART AND GRATING FOR CONVERTING IT INTO A DRAG.

enough to clear the flanges, so that the chain hooks may readily be attached. In the lower figure opposite is shewn a midpart turned into a drag or bottom box by the simple expedient of casting a stiff grating in open sand and bolting it on to the four snugs of the midpart.

In making midparts which are cast all in one it is best to have these of a depth to make various combinations with top and bottom moulds, and thereby be able to suit exactly any pattern which will go into the length and breadth of the moulding box. Suppose we set about to make a box part 48 inches by 48 inches and wish to provide for the future. The pattern is made 8 inches deep and from it we cast a top and bottom part, then we cast

Two midparts 8 inches deep.
One midpart 6 inches deep.
One midpart 4 inches deep.

With these, leaving the drag or bottom box out of consideration, there may be exactly fitted in height patterns of ten different heights from 4 inches to 26 inches. Care must be taken that these midparts have the snugs correctly bored and fitted.

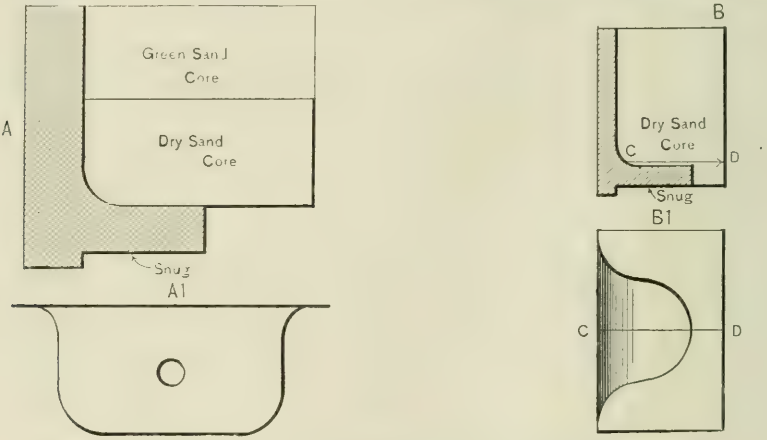


STAYING THE MIDPARTS OF LARGE FLASKS.

When midparts are long or are built high, and the pressure of the fluid iron in casting is likely to bulge the box parts where they are unsupported, this may be provided for by casting a large snug on each side of the top and bottom parts. In each snug is a 3-inch-square hole through which a bar, square in section, is passed from one snug to the other. The midparts are stayed by wood or iron wedges inserted between the bar and the midparts. In others the bow handles may be so used. See the illustration above.

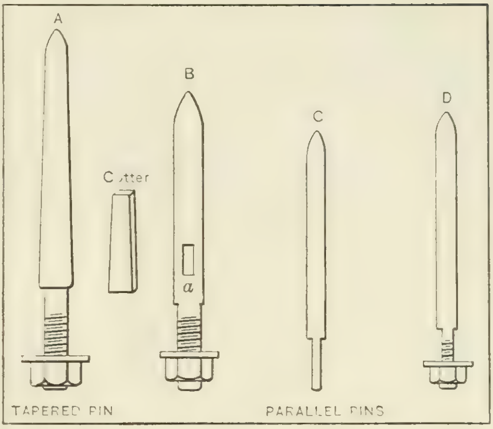
In making moulding boxes it is important that the snugs be exactly at right angles to the side and at least ⅛-inch up from the face. Many a moulding box has been spoiled by the carelessness of the moulder in placing the snugs too low. The fitter has to chip and file the snug thin before he can get the box part to bear on the corners of the frame. This snug may give way at a critical moment and so cause the loss of an important casting. Snugs should be amply heavy and have a good angling where they join the frame. Many foundries use a loose wood-pattern snug, and when the snug is drawn from the green-sand, cover over the top by means of a slate or iron plate with a covering of oil and parting sand next the metal. With such means it is impossible to have a good angling and a strong snug. A better plan is to form the top of the snug in a core box, if for large moulding boxes. For small moulding boxes form all but the bottom of the snug in a core box. See A and B, in the figure below.

Snugs of large box parts which are subject to great strains, but not great enough to require holding down by means of binders, ought to have snugs as A1, below. This shape gives space for the "cramps" or "clamps," as they are variously called, to be fixed to the snugs, a space not so available on rounded snugs. The cramps hold the various parts of the moulding box together when turning or rolling over the mould, and also when casting.



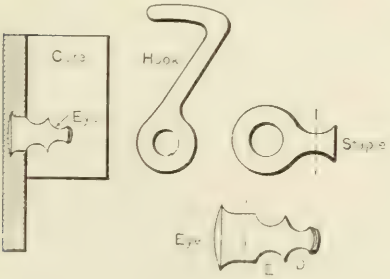
SECTIONS SHOWING HOW TO FORM MOULDING BOX SNUGS PROPERLY.

Pins for Moulding Boxes.—On page 701 are illustrated a few pins which are much used. A is a tapered pin with the shank and body joined by a gradual increase in diameter instead of having a sharp shoulder. The taper of the pin allows the mould to go from the vertical when being parted. The taper pin is allowable only for short lifts and must be square at the shoulder. B is a parallel pin with a cotter hole through it. The under part of the cotter hole at A must be a little under the line of the snug of the top part, so that the cotter will tighten itself between the snug and the upper part of the cotter



PINS FOR FLASKS.

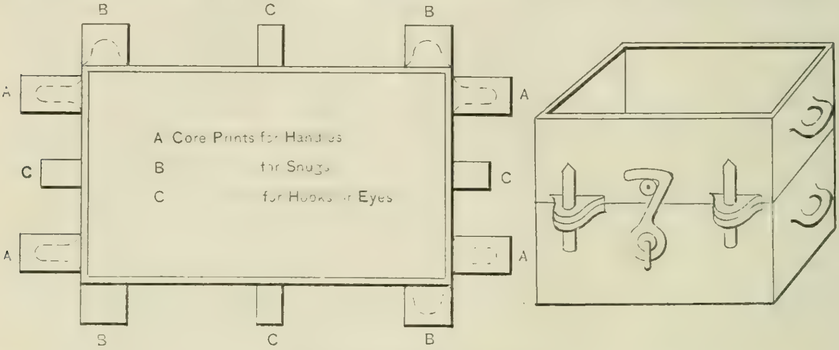
hole. This pin is excellent for fast working. Where casting strains are not great the cotter-pin allows of the moulding box being fixed ready for casting within a few seconds of closing the mould. The pin is made of a heavier section than the others to make up for the weakening effect of the cotter hole. C is a pin which is used to best purpose only on small box parts, and is then rivetted in. It is often used on large moulding boxes and is fixed in the pin hole by means of three moulder's sprigs, or in some other unsatisfactory way. It is thus the cause of endless waste of time and misjointed castings. This pin ought to be left to its proper place as of use on small box parts only. D is a useful pin for lifts from 4 to 24 inches, or longer if required. It may be transferred from one box to another at very short notice, and when screwed into position by means of the nut, causes no bother by coming loose. It is used on boxes up to the largest sizes. Unless in fairly constant use, box parts having screwed pins with nuts should have the pins taken out when the boxes are sent to the yard. When box parts are sent to the yard with the pins in, they should be placed so that the pins hang downwards. This keeps them from wasting at the neck so readily as they would otherwise do, and so prevents them working loose. Pins in crane box parts should never be rivetted in. If they work loose they cannot be tightened again unless with a great deal of trouble.



FITTINGS FOR REPEAT-WORK FLASKS.

Moulding Boxes for Repeat Work.—In making moulding boxes for castings in constant demand, it is hardly necessary to say that in suitability for the patterns to be moulded and in the fit and equipment of the box itself the very best obtainable is none too good. I shall consider these box parts as being designed to be lifted by hand and this may be done with boxes up to 4 feet by 4 feet. For the larger sizes of hand boxes the thickness of metal tapers from ⅝-inch to ½-inch, and in the smaller from ½-inch to ⅜-inch, the lesser thickness being at the joint.

Box-part patterns when cast ought to be machined true on the face. On these are screwed prints for the snugs, handles, and hooks and eyes. These pattern moulding boxes, when the complement of box parts is cast, are kept carefully for future use, either for replacing breakages or for extending the outfit of boxes. There are similar patterns for each running size. The patterns having snug and handle prints in position require no verification as to correct position when next they go into the foundry to be worked from.



FLASK FOR REPEAT WORK.

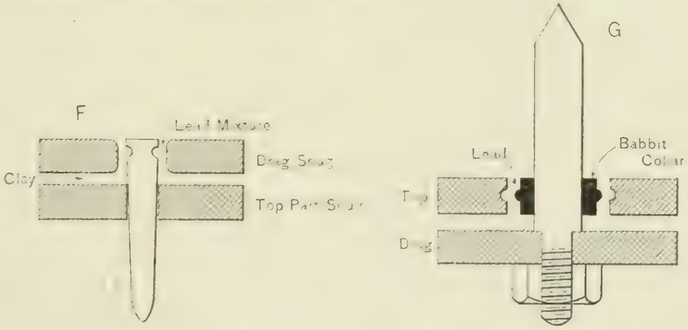
It may sometimes be possible to use, with the same drag, top parts differing as regards depth or width of bar, so that jobs may be changed by changing the top parts only. In making midparts, when these are required, the pattern of the drag may be used, the bars stopped off in the sand, and the cores carrying double snugs, double hooks, etc., may be used.

The casting into the sides of the drag of the staple carrying the hook, and casting the eye into the sides of the top, completely obviates the need of any fitting as regards these useful adjuncts. This is done by printing the iron pattern of top and drag as mentioned, ramming the connected hook and staple into one core and the eye into another core, allowing the end of the staple or eye, as the case may be, to project and be held by the metal.

The steps or different diameters on the eye allow for working the box parts with or without plate patterns. For turning or rolling over a plate pattern the hook would engage at D, in the figure foot of page 701; when closed ready for casting the hook would engage at E.

A method of fitting small moulding boxes for use with plate patterns, or ordinary patterns, for that matter, is by fixing in the pins by means of a mixture of lead and zinc poured round the pin. This is largely used in some parts of Great Britain and makes a very good fit. The snugs of the top parts are bored to a template. The snugs of the drags have cored holes, the holes having a countersink both ways, and are half an inch or so larger than the pins. The parallel pins as F, below, are made to stand vertically in the top-part holes. A thin piece of stiff clay is then made to surround the pins, over which is placed the drag, the large holes in the snugs of which allow the indented ends of the pins to come up through. The lead and zinc mixture is then poured round the pin. This plan makes a good fit even if the top-part holes are not bored exactly to the template. The pins will stand a surprising lot of work without coming loose. If they do come loose, the lead mixture is melted out and the pin re-fixed by pouring as before.

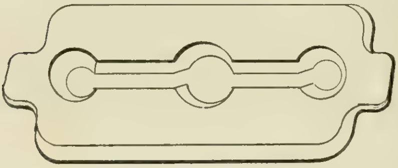
Another method somewhat similar to the above is shewn in G, below. In this the large hole is in the top-part snug, and is cast with a small recess to hold the lead in position. The holes in the drag snugs are bored to template and the pins are held by a nut on the under side. A babbit-metal collar, smooth inside, but roughed outside, is dropped over the pin, making an accurate but movable fit. The drag is placed upon the top part, each collar coming up into the large holes in the drag snugs. Lead or a lead and zinc mixture is now poured round each collar and so fixes it. With turned pins this makes the best fit of all I have mentioned. For sustained accuracy it is unequalled, and may be arranged to suit parallel or taper pins.



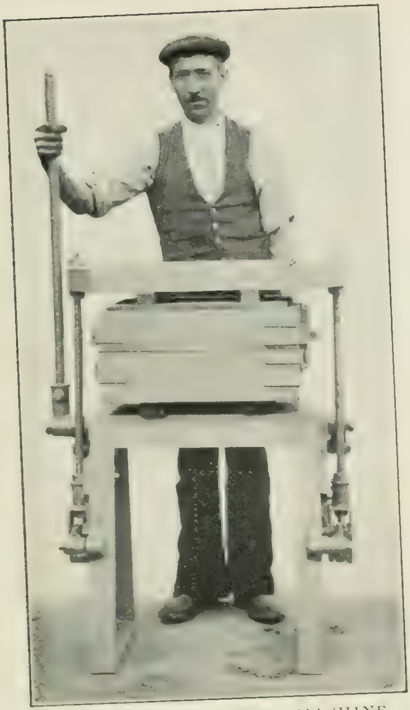
PINS FOR FITTING SMALL FLASKS FOR USE WITH PLATE PATTERNS.

In designing box parts see that bars, sides, and snugs are well proportioned, as much repairing will thereby be avoided. For the same reason, and also the added one of safety for life and limb, put the best iron into the moulding boxes. It is neither wise nor economical to use rubbishy iron for this purpose.

Use of Snap Flasks.—Snap flasks are used in Great Britain to a very limited extent, but are largely used in the United States. In Great Britain it is probable that their use will become more extended as time goes on and foundrymen become acquainted with their uses and capabilities, and also with their limitations. Knowledge of the latter is not unimportant. The snap flask, I may explain for the benefit of the uninitiated, is usually made of wood, is hinged at one corner, and has a catch at the other. When the sand is rammed and the mould made and closed, the snap flask is released by lifting the catch and so allows the flask to open. The mould is then transferred to the floor by means of a bottom board, of which there is one for each mould. The snap flask is now ready for making the next mould. These moulds, having no box part to hold them, have weights of the same area as the moulds placed upon them for the purpose of holding them down and so preventing straining or lifting. Suitable openings are made in the weights through which the metal is poured into the runner or "git." The number of weights required by each worker of a snap flask is what will cover the number of moulds which he can cast with one hand ladle of metal. After pouring into the moulds the contents of each hand ladle, he transfers the weight from those he has just cast to those about to be cast. About six or eight weights will thus be found sufficient for each worker.


WEIGHT FOR SNAP FLASK.

When the moulds are put on the floor they are placed firmly one against the other so that each mould is supported on two sides, with the exception of the moulds first and last in each row. Beginners have considerable difficulty in pouring them, so that they shall not run out, but that is overcome as experience is gained. Snap-flask moulding is largely confined to castings of a light character which are shallow in depth and not extensive in superficial area. When castings are deep the sides of the mould are readily burst out, and the same thing may hapen if the superficial area demands fast pouring so that the surface of the casting may be without flaw. There is a large field, however, for snap-flask moulding where the risks mentioned are quite avoidable. The use of this mode of moulding is certain to increase, considering what a small outlay for plant it requires.



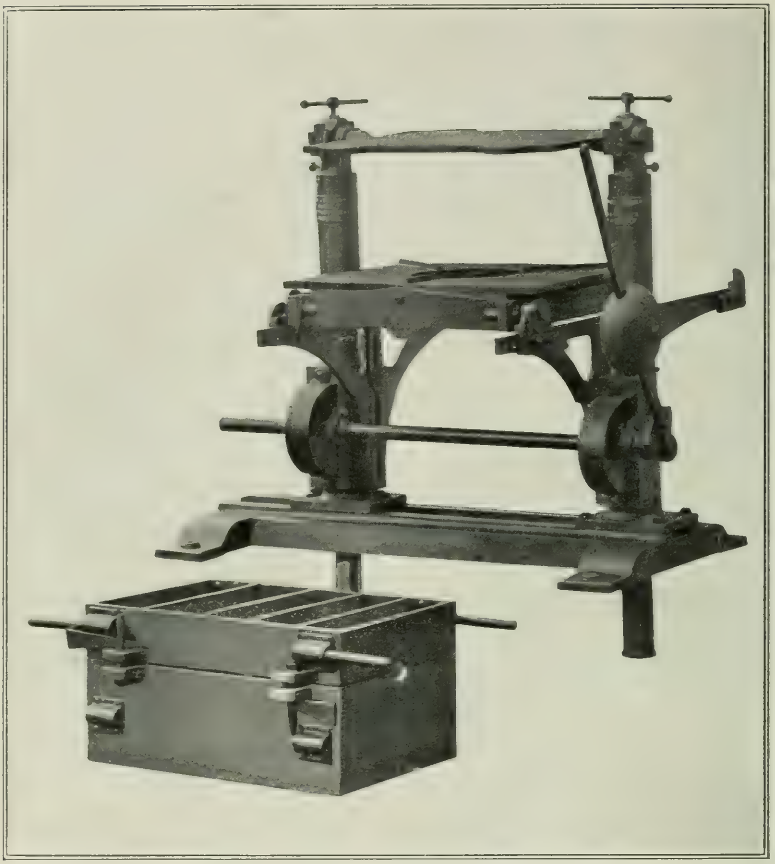
HAND-PRESS MOULDING MACHINE.
For light work in flasks up to 18 by 15 inches. Samuelson & Co., Ltd., Banbury.

An almost indisputable adjunct to the snap flask is the sand press. The various methods of working patterns, whether loose patterns, using odd-sides, or with plates, or any modifications of these, may be applied on the sand press. With plate patterns the top and drag are pressed or rammed at the same time and with the same movement of the lever. The sand press is not adapted to make three-part moulds unless with very special arrangements which need not be detailed here.

Beating the Moulding Machine.—A moulding machine is one in which the sand is rammed or pressed by compressed air, steam, or hydraulic power, and in which the pattern is made to leave the mould or the mould to leave the pattern, by mechanical means. This leaves out of consideration the numerous machines which are rammed by hand, whose sole function, and that a useful one, is accurate drawing of the pattern from the mould.

We hear of the great number of moulds which may be made in a day using these machines, and comparison is made with the number made by hand in a similar time, to the disadvantage of hand moulding. A moulding machine was set to work on a new plate pattern and by the time the day's cast was over 1,250 castings, each about 2 pounds weight, had been made; and yet, taken week by week, that machine was a failure as regards cost, when compared with the cost of similar castings made by hand. More castings per plate pattern may be made per day by the machine, but the labour attending the machine, the upkeep of the machine itself, and the supply and conveyance of power to work the machine, may counterbalance much of the advantage of increased output obtained from one pattern.

It is misleading to compare an outfit of ancient box-parts made of cold-blast iron (as the hot blast had not then been invented), in which



SPECIAL PLATE-MOULDING MACHINE FOR REPETITIVE WORK.

Samuelson & Co., Ltd., Banbury.

is worked an iron pattern which has been filed for half-an-hour by one who knows nothing of moulding or a moulder's requirements, with the use on a moulding machine of a pattern and plant which are the product of the best skill of the expert. If the same qualities of precision and exactness in fit and finish of patterns and general plant, and the same supervision, attention, and energy, be devoted to the working of patterns by the best hand methods as are usually given where machine moulding is practiced, then hand moulding, except in specialised cases, is in small danger of being ousted, at least in the near future. What the future contains no man knows, but the day of the moulding machine for general work is not yet.

Coal Dust.—In making coal dust for moulding purposes one would expect that coal containing the greatest percentage of carbon would be the most suitable, and yet it is not so. Anthracite with fixed carbon 93 per cent, and ash 7 per cent, made into coal dust, gave the casting a spotted appearance, each spot indicating where a particle of the coal had been. The remainder of the casting was dark and dull. Using an ordinary coal containing hydrocarbons, that is, a bituminous, long-flaming coal having 14 per cent. ash—the spotted appearance was absent and instead there was a very much lighter, brighter skin on the casting, uniform in appearance all over. Everyone knows the appearance indicated, and it is due to the absorption by the red-hot casting of the hydrocarbons liberated from each particle of coal by the heat of the newly poured metal. Carbonic oxide gas also probably assists in forming the skin on the casting. A mixture of equal quantities of anthracite and bituminous coal in the facing sand gave an appearance in the casting midway between the pure anthracite and the pure bituminous coal. The spotted apearance of the anthracite was there, but the body of the casting was lighter than when using anthracite alone, and this lighter appearance was undoubtedly due to the bituminous coal present. The total weight of coal dust used in each test was the same.

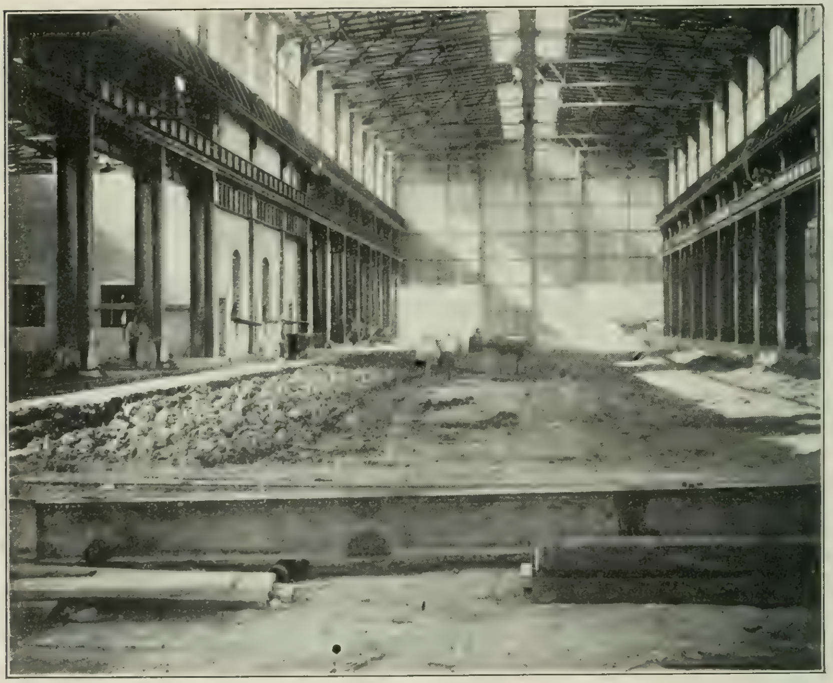
It is well for foundrymen who have not reliable sources of supply to make their own coal dust. How to test the materials offered in the market will be shewn later on. To make coal dust, the fine coal is dried on a plated floor, with flues underneath, a moderate heat being used so as not to fire the coal, or volatilise in any appreciable degree the hydrocarbons contained in the coal. When the fine coal has cooled it is ground in a mill having two French burr stones, the under one being fixed and the top one running. The stones are horizontal, and the fine coal fed into a hole in the middle of the top stone is ground as it passes towards the circumference of the stones.

DISINTEGRATOR FOR FOUNDRY USE.
Christy & Norris, Chelmsford.

Disintegrators are more and more coming into use for pulverising and reducing to powder all kinds of materials, and with these coal dust may be produced to any degree of fineness. Pan mills are also used for grinding coal dust, but the product is suited only for castings where smoothness of skin is not a first requirement. Owing to its coarseness, the coal dust produced in pan mills is quite unsuitable for light castings, unless after an excessive amount of milling and waste of time and power.

Facing Sand.—Every moulding sand consists primarily of silica with small percentages of oxide of iron, alumina, and silicate of alumina, or clay, as the materials which bind the particles of silica together. Sometimes, but not often, there may be no oxide of iron present in the moulding sand.

Water is present as "combined water" even when sand is considered to be dry. Sand is called "burnt" when this combined water has been driven off by the action of heat. Added water will not produce "bond" unless combined water be present. Lime must be practically absent as it increases the fusibility of the sand.



EXCAVATING THE FLOOR TO BE FILLED WITH MOULDING SAND, WEST ALLIS FOUNDRY OF THE ALLIS-CHALMERS CO.

SAND-MIXING AND CORE ROOM, DEUTSCHE NILES-WERKZEUGMASCHINEN-FABRIK, BERLIN.

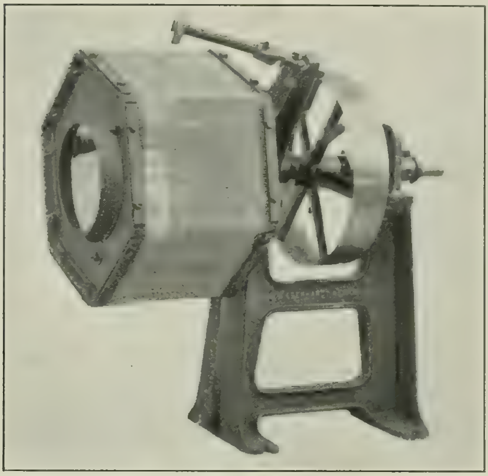
MOULDING SANDS.

| | Mansfield Sand. Per cent. | Erith or London Sand. Per Cent. | S. Staffordshire Sand. Per Cent. |
|---|---|---|---|
| Silica | 94.02 | 87.86 | 93.40 |
| Alumina | 3.73 | 5.04 | 4.06 |
| Oxide of Iron | 2.07 | 4.28 | 2.14 |
| Lime | —— | 0.30 | —— |
| Loss on ignition | —— | 2.41 | —— |
| | 99.82 | 99.89 | 99.60 |
| Clayed matter removable by washing | 4.70 | —— | 4.90 |

These may be taken as examples of good moulding sands, the London sand being yellow, the other two red.

Beyond the analysis, the suitability of a sand for particular moulding purposes depends largely on the state of subdivision of the particles or grains of silica. If these are large, the sand may be suitable for heavy work, but certainly not for small castings, unless with a considerable preliminary mechanical treatment.

In considering the most suitable treatment to produce the best moulding sand we have to take into account the sand available and also the class of castings for which the sand is to be used. Moulding



EBERHARDT'S AUTOMATIC SAND SIFTER.

sand for dry-sand and heavy green-sand work may be mixed simply by shovelling and riddling, as the surface of the mould is usually black-washed or blacked and sleeked. The granular formation of sand which has not been rolled or milled allows of a freer use of water than is the case with milled sand. Where the proper proportion of clay is present in the sand, hand mixing makes a better sand for heavy castings than milling will. If the clayey matter be deficient, then milling will improve it by more thorough distribution of the clay and bonding materials. For light castings and castings of an intricate character milled sand is a necessity. For ornamental castings and fine figure work, in some cases the sand after milling is taken in small quantities, formed into a ridge, and rolled or brayed by means of a roller held in the two hands. This rolling makes it of a consistency and fineness such as no other treatment produces.

The milling or rolling of sand has the effect of reducing the grains of silica to a greater degree of fineness. Seen under the microscope, such grains have largely lost their angular structure and have a flattened appearance. In short, the reduction in size and the flattening of the grains of silica, together with the thorough admixture of the clayey matter, gives milled sand its "tough" quality and degree of fineness. It follows as a consequence that for fine castings, simple mixing by hand, or

CENTRIFUGAL SAND-MIXING MACHINE.
Wm. Sellers & Co., Phila., Pa.

by machines of the centrifugal type, is permissible only if the sand be by nature of a finely granular character, and even then it will not equal sand which has been milled or rolled.

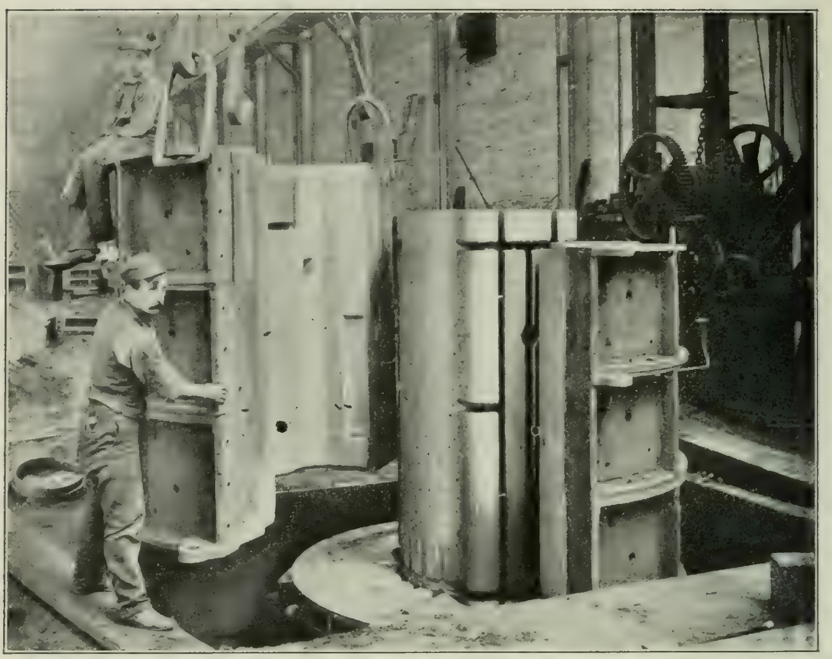
Mixing the Facing Sand.—The new moulding sand is dried on an iron plated floor having flues underneath, and is allowed to cool previous to being put into the pan mill. Hot facing, like any other hot sand, sticks to the pattern by having some of the water vapour condense on the pattern. The drying of the sand is simply for the purpose of preventing the sand caking during the milling. Dried sand in a fast-moving mill has more the appearance of a fluid than of a solid. The result is a thorough mixture of the sand and the added coal dust. Taken from the mill, the sand is damped, riddled, and sieved, and is now ready for work.

HEAVY WORK IN THE SOUTH FOUNDRY OF THE ALIS-CHALMERS CO., MILWAUKEE, WIS.

In the mixtures of facing sand which are given the coal dust is made from bituminous coal containing 14 per cent. ash. This is coal of fairly good quality.

FACING SAND FOR HEAVY AND MEDIUM GREEN-SAND CASTINGS.

| | | |
|---|---|---|
| New moulding sand........................ | 10½ parts or | 60 per cent. |
| Black sand from moulding floor.......... | 3 " " | 17 " " |
| Coal dust .................................. | 4 " " | 23 " " |



CORE AND MOULD FOR LOW-PRESSURE CROSS-HEAD GUIDE OF A LARGE ENGINE, FOUNDRY OF THE WESTINGHOUSE MACHINE CO., PITTSBURG, PA.

FACING SAND FOR LIGHT CASTINGS.

| | | |
|---|---|---|
| New moulding sand | 14 parts | 64 per cent. |
| Black sand from moulding floor | 4 " | 18 " " |
| Coal dust | 4 " | 18 " " |
| (Percentages are approximate only). | | 100 |

If the coal dust be rich the quantity used may be lessened, and this may also be done where skin drying is employed, or if heavy coats of blacking are dusted on the mould and are then sleeked or smoothed. These mixtures are given only as examples of first-class facing sands and may be varied as required for particular applications.

The facing sand used in Falkirk district, noted for fine castings and ornamental work, is made up of:

| | | |
|---|---|---|
| Erith or London sand | 56 parts | 67.00 per cent. |
| Black sand from the moulding floor | 14 " | 16.50 " " |
| Coal dust | 14 " | 16.50 " " |
| (Percentages approximate only.) | | 100.00 |

The Erith or London sand is dried and thoroughly incorporated with the black sand and the coal dust by means of the pan mill. For intricate drawbacks the sand is in addition rolled by hand or "brayed" as already mentioned. No blacking is put on these moulds. For heavy castings the black sand is largely increased, the coal dust decreased, milling is not employed, and the moulds are blacked and sleeked.

Blackings or Facings.—These are used on the face of the mould only, charcoal made from wood being used on green-sand moulds, "patent" or mineral blacking on dry-sand and loam moulds. Plumbago is sometimes used by itself, but mostly as an aid to the charcoal and mineral blackings to give a fine skin to the castings.

With a ball mill of a very modest size, charcoal blacking sufficient for a large foundry may be readily and cheaply made. Charcoal blacking made from the heavier woods is best, as the liability is reduced of such blacking washing before the metal. It is to be remembered that blacking which washes away and rises with the metal appears as so much dirt in the casting. A little plumbago dusted on the top of the charcoal blacking and the two sleeked in together gives weight and body to the facing, helps to prevent washing, and improves the skin of the casting.

"Patent" or mineral blacking is made from the residual carbon obtained from the retorts used in distilling shales or earths containing oils, and also from ordinary gas-work retorts. This carbon is exceedingly hard, of high specific gravity, and requires special machinery for its production. As a coating for loam and dry-sand moulds it is unequalled. It is mixed with clay water of the consistency of a thick cream and is put on the mould by means of a swab or a brush. If plumbago be added the skin of the casting is made to have a lighter colour. It is more economical to dust the dry plumbago on the top of the newly black-washed mould. The plumbago is on the surface, where it is wanted, and it also facilitates sleeking of the black wash. The sleeking of the black wash on loam moulds is much less practiced than formerly. A camel's-hair brush is used to remove all inequalities on the surface of the black wash and is used wet. A little plumbago in the water used with the camel's-hair brush, helps the appearance of the casting. When finishing is done by means of the camel's-hair brush no loose plumbago is dusted onto the mould. It should be seen that the plumbago is of good quality. Owing to its high price it is subject to much adulteration. How to judge its quality and purity will be shewn in the next paper.

# COST-FINDING METHODS FOR MODERATE-SIZED SHOPS.

## COSTING AND TRACING AT THE COTTRELL PRINTING-PRESS FACTORY.

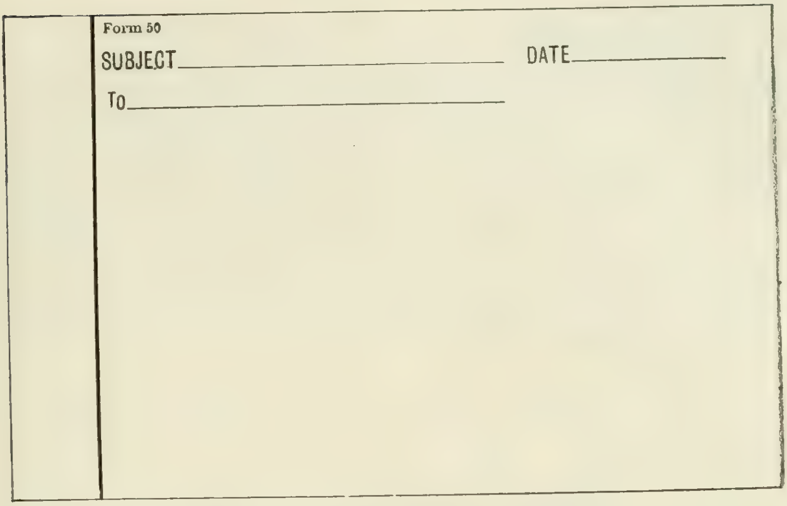
*By Horace L. Arnold.*

The series of articles of which this is the third began in December with an account of a system in use in a well-managed boiler shop. Last month the example taken was a machine-tool building works using the premium plan. Next month's paper will be by William Magrutor, and will give the methods of an engine-building company in the southern States. The purpose of every article is to furnish a working description of a practical system, in actual use in a shop where it has stood the test of time and proved sufficient, and with it to give fac-simile reproductions of all forms and blanks. This makes the papers particularly useful to those concerned with shop accounting.—THE EDITORS.

THE printing-press factory of the C. B. Cottrell and Sons Company, at Westerley, Rhode Island, employs 450 hands. The factory, for the purposes of this article, comprises the factory offices, the machine shop, the forge shop, and the foundry; the factory officials chiefly instrumental in production and costing are the general manager, head of the "Department of Production" (herein designated the "head"), the machine-shop superintendent, the production-order clerk, who makes the sub-production orders, the transfer and tracing clerk, the stores keeper, the forge and foundry clerk, the foundry foreman, the smithy foreman, and the cost clerk.

The following terms will be used;—Principal Production Order, meaning an order for the factory to produce an entire construction, as a printing press; Sub-production Order, calling for a single component or one lot of single components; Repairs Production Order, and the Stores Replenishment Production Order, styled "S K" production order. There is a fourth form of minor production order, used to meet the case of compound components, where several simple elements are finally united to make up a single structure.

The Principal Production Order.—All production orders emanate from the head of the department of production. This principal production order is made by the head on Form 1, general factory correspondence, which see, and consists of the date, the number of production wanted, the production symbol, and the vivifying signature of the head in the lower right-hand corner. These forms are type-written, and



Form 50

SUBJECT____________________ DATE__________

To____________________

FORM I. DEPARTMENTAL CORRESPONDENCE.

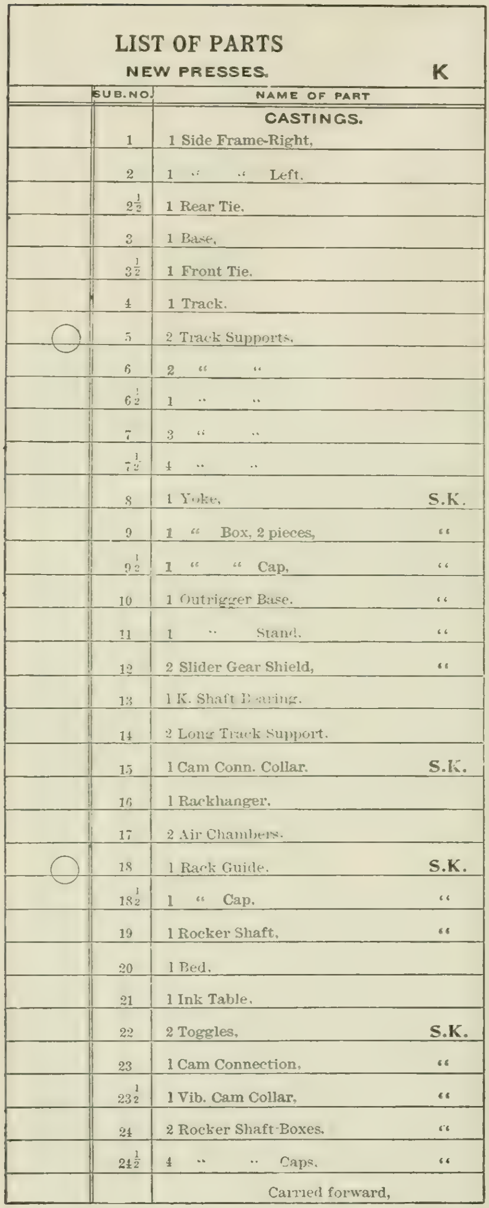
Original is about 8 by 5 inches, printed and ruled in black on white paper.

are brief. Thus "6 12K Presses" is all the product specification needed to cause the factory to begin the construction of six complete 12K printing presses.

Nine copies of each principal production order are made in carbon, two going to the production-order clerk, who files one in his own file and the other in a file which he keeps, but which belongs to the head; one goes to the machine-shop superintendent, and one each to the purchase agent, the route clerk, who selects lines of transportation for shipments, the stores keeper, the foundry foreman, the forge and foundry clerk, and the transfer clerk.

The principal production order may call for several thousand single component productions, as determined and specified by the "Lists."

The Machine Shop Superintendent.—Principal production orders go to the machine-shop superintendent, with notification of shipment date, which is expected to be promptly met. The transfer clerk fills many of the duties of assistant to the machine-shop superintendent, and gives out all the work. The superintendent has general charge of work in progress, and directs the sequence of operations with a view of meeting shipment dates. The superintendent has copies of all lists, and his efforts are directed principally to forwarding operations on components so that they shall be delivered to the erecting floors when needed there.



| | | | |
|---|---|---|---|
| | **LIST OF PARTS**<br>**NEW PRESSES.** | | **K** |
| | SUB. NO. | NAME OF PART | |
| | | **CASTINGS.** | |
| | 1 | 1 Side Frame-Right, | |
| | 2 | 1 " " Left. | |
| | 2½ | 1 Rear Tie. | |
| | 3 | 1 Base, | |
| | 3½ | 1 Front Tie. | |
| | 4 | 1 Track. | |
| ○ | 5 | 2 Track Supports, | |
| | 6 | 2 " " | |
| | 6½ | 1 " " | |
| | 7 | 3 " " | |
| | 7½ | 4 " " | |
| | 8 | 1 Yoke, | S.K. |
| | 9 | 1 " Box, 2 pieces, | " |
| | 9½ | 1 " " Cap, | " |
| | 10 | 1 Outrigger Base. | " |
| | 11 | 1 " Stand. | " |
| | 12 | 2 Slider Gear Shield, | " |
| | 13 | 1 K. Shaft Bearing. | |
| | 14 | 2 Long Track Support. | |
| | 15 | 1 Cam Conn. Collar. | S.K. |
| | 16 | 1 Rackhanger. | |
| | 17 | 2 Air Chambers. | |
| ○ | 18 | 1 Rack Guide. | S.K. |
| | 18½ | 1 " Cap. | " |
| | 19 | 1 Rocker Shaft, | " |
| | 20 | 1 Bed. | |
| | 21 | 1 Ink Table. | |
| | 22 | 2 Toggles, | S.K. |
| | 23 | 1 Cam Connection, | " |
| | 23½ | 1 Vib. Cam Collar, | " |
| | 24 | 2 Rocker Shaft-Boxes. | " |
| | 24½ | 4 " " Caps. | " |
| | | Carried forward, | |

FORM 2. PRINCIPAL-ORDER COMPONENT LIST. "CASTINGS" FORM. FORGINGS FORM IS SIMILAR. BOUND DETACHABLY IN BOOKS.

Original is 4 by 10 inches, ruled in red and blue on white paper.

Lists.—The lists originate in the drawing room, and are of two sorts, same general appearance, "Castings" lists, and "Forgings" lists. Every component not a casting is constructively a forging, and is listed in the forgings list, whether really a forging or not. These lists are printed (see Form 2) and are detachably bound in books with substantial stiff covers, and are absolutely complete for each regular construction. Since all the foremen and the stores-keeper and purchase agent each have principal construction-order copies, the factory may at once begin the detail work of producing the needful components. The purchase agent knows what is to be bought from outside sources and the foundryman and the smithy may begin the production of castings and forgings.

Casting Production on Principal Production Orders.—The foundry foreman has a copy of each principal production order. He also has printed lists of the castings for the order. Besides this printed list, the foundry foreman has cabinets of trays, one tray inscribed with the symbol of each regular production. These trays have card grooves with the list numbers and symbols, in which cards stand upright, bearing the corresponding symbols, one card for each individual piece of casting in the principal production. According to work in progress, the foundryman selects patterns and begins the order filling, turning each card with its inscribed face to the rear as soon as the casting it calls for is done. When a pattern is given out in the foundry the number of castings called for by the order is made. Consequently, as soon as all the cards in one of the foundry cabinet trays have their faces turned to the rear, the foundry foreman knows he has made castings for the whole order.

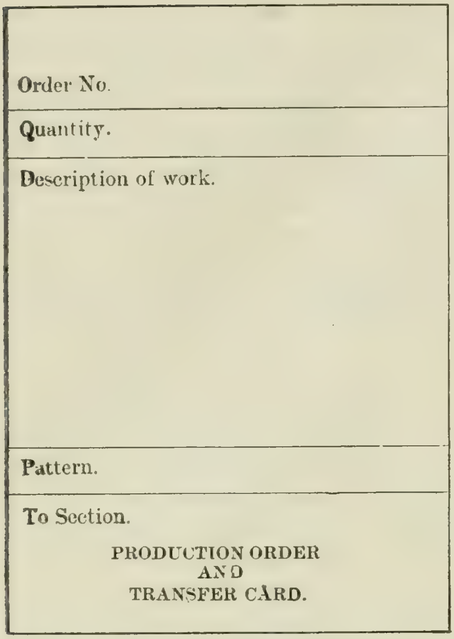
As soon as a casting is made from any pattern, the foundry foreman notes the weight of the piece on the back of the card which bears on its face the corresponding piece symbol. This card stands in the similarly marked groove in the castings component tray, and its tray, in turn, is marked with the principal product symbol. This gives the foundryman a complete weight record of all components he ever made once, in such form as to be instantly available.

Drawings and Blue Prints.—Production begins of course in the drawing room, where the machines to be built are designed, and drawings are made of the complete press and of each single piece which goes to make up the whole.

Construction-drawing blue prints, side and end elevations, and such sectional elevations as are needful, go to the erection foremen, who alone have use for them, while books of quarter-size blue prints of all details of each particular press are made up and bound in the blue-print room, and these are supplied to the erectors, to the foremen of the factory departments, and to the stores room, where the interchangeable components are stored.

Forgings Production on Principal Orders.—The forge and foundry clerk has complete forgings and castings lists of every principal construction, and also has a copy of every principal production order. The foreman of the smithy has bound books of quarter-sheet size blue prints for all forging details of every principal order.

Upon receipt of the principal production order, the forge and foundry clerk selects the forgings card tray belonging to the ordered product; this tray has card grooves numbered to correspond with the components of the forging list, and each groove has the usual card standing in it, bearing the groove number. The forge and foundry clerk compares the cards with the groove numbers, sees that all grooves are filled with cards standing with symbols to front, and sends the tray to the foreman of the smithy, who proceeds with the forgings, using his book of blue-print details, of course, to produce the correct forms and sizes. This places the forgings in work. As fast as the forgings are completed in required numbers of each, the piece card in the tray is turned symbol to the back, and thus the foreman is informed by simply glancing at the tray when the order is completed.



Order No.

Quantity.

Description of work.

Pattern.

To Section.

PRODUCTION ORDER
AND
TRANSFER CARD.

FORM 3. PRODUCTION ORDER AND TRACER. DIFFERENT COLORS FOR DIFFERENT PRODUCTIONS.

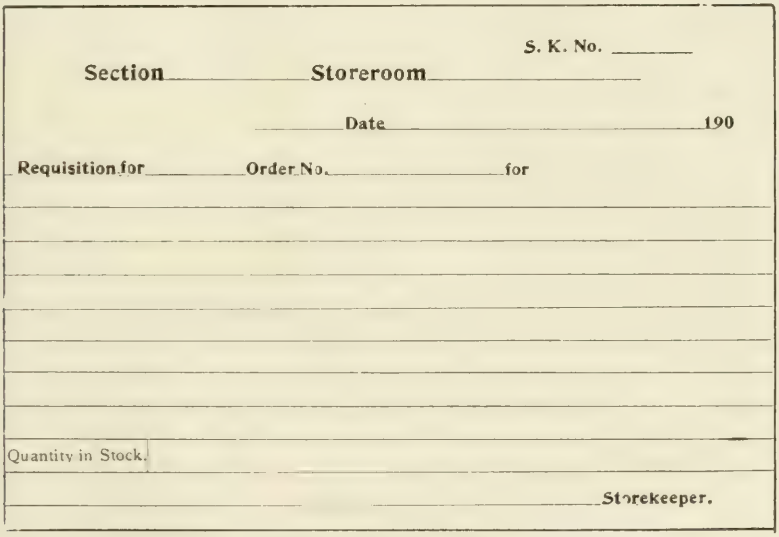
Original is same size; filled by production-order clerk, finally sent to transfer clerk and destroyed when the order is shipped. Form 5 is the same, but deep red and stamped S K. It takes the same course but goes finally to cost clerk.

The Production-Order Clerk.—The production-order clerk writes the sub-production order cards for all productions except the repairs and S K castings orders, which are written by the transfer clerk, as will be specified hereafter.

Principal production orders, made on Form 1, are sent to the production-order clerk, who by reference to his corresponding book lists of castings and forgings, proceeds to write the sub-production orders on Form 3, all printed alike, all of the same size, but of different colors for different varieties of presses. These sub-production orders have two functions;—first that of ordering production by the factory, and, second, that of "passport," or "transfer" card. This production order and transfer card is always kept in the same factory department with the piece it authorizes, from the time the component has tangible form until it is completed. No factory department or official will receive any component or material unaccompanied by this production order and transfer card. Consequently any piece without a transfer remains in the department where this lack is first discovered, and cannot be moved out of this department until its whole story is known, and a new transfer furnished it; then it again becomes mobile, and may proceed to its proper destination.

Having filled all the component production-order and tracing cards for both forgings and castings, the production-order clerk sends them to the transfer clerk, at the transfer desk, located about the middle of the machine-shop floors, where the transfer clerk holds them until ordered by the head to begin machine-shop operations on the order.

"S K and Repairs Production Orders.—A great number of parts "stock," or "S K," which go into every Cottrell printing press, are kept in the stores room, ready for use on the erecting floors. Upon receipt of a principal production order on Form 1, the stores keeper looks up his card inventory to see that he has the needful S K components ready to meet the requisitions which he knows will be made on his stores. By orders from the head of the department of product, each stores item has a maximum and minimum limit; the stores keeper replenishes his stores by filling Form 4, in carbon duplicate, and sending both original and duplicate to the production-order clerk, who makes the production orders on S K production-order and transfer cards. These cards are printed the same as Form 3, but are of a different color, and have a rub-



S. K. No. ________

**Section** ____________ **Storeroom** ____________________

________ **Date** ____________________________ 190

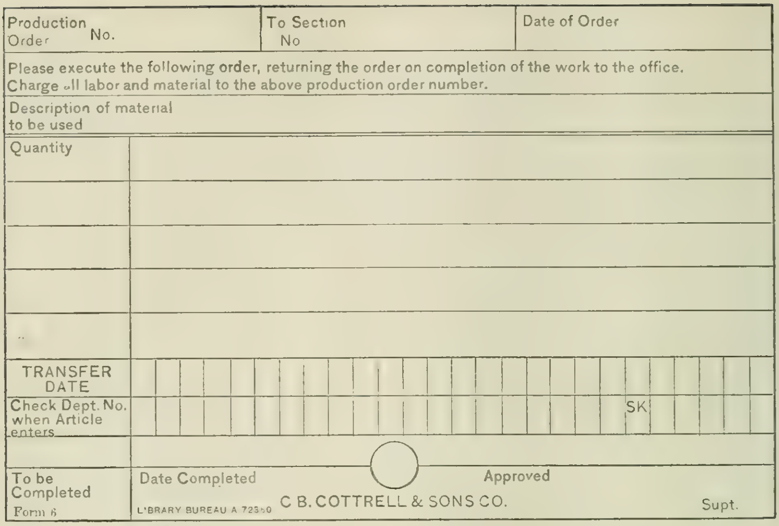
**Requisition for** __________ **Order No.** ____________________ **for**

Quantity in Stock.

____________________ ____________________ **Storekeeper.**

FORM 4. STORES-REPLENISHMENT REQUISITION.

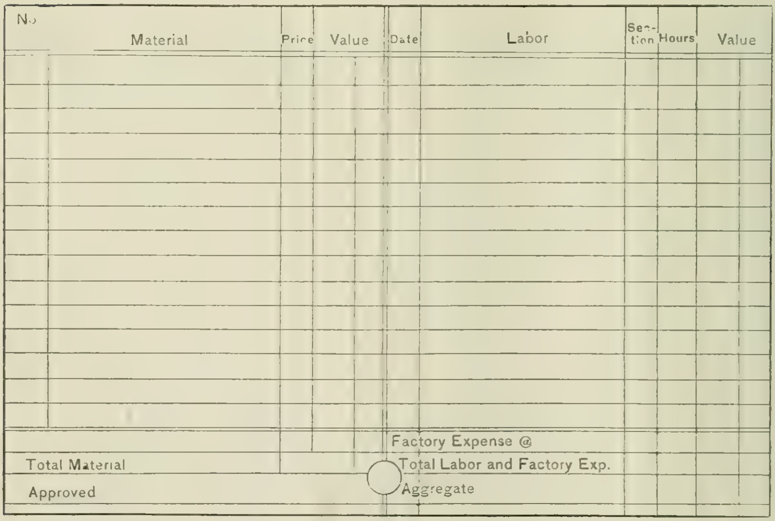
Original is about 6 by 4 inches; filled in duplicate by stores keeper and both copies sent to production-order clerk. He makes corresponding S K order and tracer and sends them to transfer clerk, who fills out Form 9 for either forgings or castings and sends one copy of Form 4 to stores keeper and one to machine-shop superintendent. This latter also goes finally to stores keeper, who destroys both copies after he has received and recorded the components demanded by the form.



| | | |
|---|---|---|
| Production Order No. | To Section No | Date of Order |
| Please execute the following order, returning the order on completion of the work to the office. Charge all labor and material to the above production order number. | | |
| Description of material to be used | | |
| Quantity | | |
| | | |
| | | |
| | | |
| | | |
| TRANSFER DATE | | |
| Check Dept. No. when Article enters | SK | |
| | | |
| To be Completed<br>Form 6 | Date Completed<br>L'BRARY BUREAU A 72350 C B. COTTRELL & SONS CO. | Approved<br>Supt. |

FORM 7. FRONT. SPECIAL OR REPAIR PRODUCTION ORDER.

Original order is 6 by 4 inches, ruled in red and blue on a yellow card. Form 8 is identical, but thinner. Form 7 is filled in carbon duplicate by production-order clerk when filling Form 8. 8—the original—is sent to transfer clerk, who makes needful production orders on Forms 3 and sends them to forge and foundry clerk. 7—the duplicate—goes to cost keeper. Finally, the transfer clerk sends Form 8 also to the cost keeper.



| No | Material | Price | Value | Date | Labor | Section | Hours | Value |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
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| | | | | | | | | |
| | | | | Factory Expense @ | | | | |
| Total Material | | | | Total Labor and Factory Exp. | | | | |
| Approved | | | | Aggregate | | | | |

FORM 7. BACK. CONTAINING COST AND DATE SPACES.

ber stamp S K impression at the top. With each S K order an S K tracer is made, a stiff white card, about 2½ by 1½ inches bearing the rubber-stamp impression "S K". The S K orders and S K tracers are placed together, held with rubber bands, and sent to the transfer clerk. The production-order numbers are written on Form 4 and duplicate by the production-order clerk, and both are sent with the S K cards and tracers to the transfer clerk.

There are a great many "Repair" orders to be filled. If possible, these are filled from the stores room. If not in stock, then the production-order clerk makes production-order cards on Form 3, marked "R" at the head, and fills tracers for them with order number and component symbol as with the orders on Form 3, puts them together, and sends them to the transfer clerk as before.

There are certain compound components, made up of two or more pieces, which are listed in the assembled form as one single component. There are also miscellaneous orders for a few pieces only. All such orders are made by the production-order clerk on Form 7, with carbon duplicate, and by him sent to the transfer desk.

Shop Messages.—Every official's desk has two baskets standing on it, one "out," one "in." There is also telephone communication where needed. Written communications are made on Form 1, placed in the "out" basket, and taken thence by a constantly travelling messenger boy, who covers a fixed route in the factory, and placed in the "in" basket on the desk of the official addressed. These baskets, the telephone, and the messenger boy, make communication between department heads easy and rapid. The "cross" form of the factory floors makes a radius of 200 feet from the transfer desk cover the machine-shop plant, so that the transfer clerk can easily reach any factory-department head he wishes to see in person. Quick and easy communication between department heads is of the first importance in factory management, and the single-floor cross plan for the machine shop greatly aids ready intercourse of officials.

The Grooved Card Trays.—Wooden trays having rows of grooves made by saw cuts, or rows of pockets made by partitions, may be said to be the dominating conception and factor of the Cottrell shop procedure. These tray grooves are about half an inch, or in some cases more, in depth, and vary in width, and are thus adapted to take the stiff production-order cards standing on their edges, and hold these cards upright. The cards held by these trays are made to give information of varied character to the officials. In the foundry foreman's office the trays are fitted to slide in large cabinets, and each tray has card-retaining and supporting grooves to hold the entire lot of cards representing the complete list of castings for one principal order. The smithy foreman has similar trays, each holding all the forging cards for one principal construction order. Each card and each groove of the forge and foundry trays bears the component number and symbol or pattern symbol, and these cards are permanent, and are only renewed when illegible from repeated handling.

The erection foremen have large card trays with numbered grooves, in which they place the component production-order cards as fast as the components are received on their own erection floor. A glance at the tray shows what has been received, and what is yet lacking. In whatever department a component rests, there is its production-order and tracing card with it, up to the time of delivery to the stores room, the "waiting" stores, or the shipping department.

The Transfer Clerk.—The transfer clerk has one assistant at the desk, and one laborer, who acts as special messenger and hand truckman. The transfer clerk must be familiar with all the tools in the plant, and must know the powers of the workmen as well, because it is one of his duties to place all orders in work for each departmental operation. Another duty of the transfer clerk is to note the transfer of each component in process of production, first from the foundry, the cutting-off room (which supplies cut rods and shafting), or from the smithy, to the machine-shop first-operation department, and then through successive factory departments to the erecting floors or shipping room, by means of written records made on Form 10 for principal-order sub-productions, or on Form 8* for compound component and miscellaneous minor-production orders, or on the S K tracer. The exact routine of component working and tracing is this: The transfer clerk sends the rough component with its production order to a "section," or machine-shop department, foreman; the foreman gives the piece, with its production order, to a workman; the workman places the production order in a small tin hanging card receiver, made for the purpose, and secured in any convenient place—at the end of his bench, or on his stool, or anywhere near at hand. Lathe hands very commonly hang these card holders on their belt-shipper handles. When the workman has completed his operation he records the time on his time card, and returns the component and time card to his foreman. Each foreman has a laborer called a "trucker," who takes the production orders to the transfer clerk, who notes the date on his tracing record, with the new department number, and directs the trucker, who

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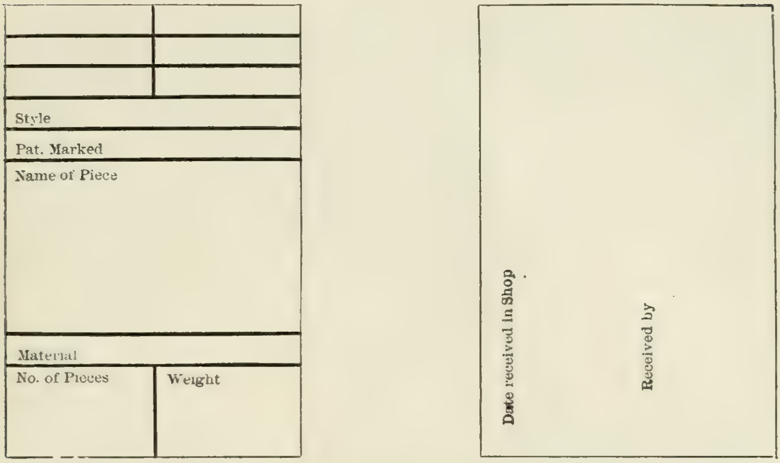
* See description under Form 7, page 720.



Style

Pat. Marked

Name of Piece

Material

No. of Pieces

Weight

Date received in Shop

Received by

FORM 9. CASTINGS AND FORGINGS MATERIAL ORDER. FRONT AND BACK. Original is 2½ by 3¾ inches, stiff card. Filled by transfer clerk from principal order lists; sent to foundry and forge clerk on orders written on Form 1; returned with weight record to transfer desk; date on back is filled by transfer clerk, and receipt by forge and foundry clerk.

then delivers the component and its production order to the foreman of the next operation department.

The transfer clerk must be familiar with the principal factory productions, and must be able to recognize their components on sight. These requirements compel the selection of the transfer clerk from the factory machinists of long experience. No special clerical training is needed. Quick perception, familiarity with factory product, and coolness and strict attention to routine, are the special qualifications which the transfer clerk must have, and he must also be able to make dates in small plain figures.

The Transfer Clerk's Desk.—This desk has ample room for two writers, standing height, with two high chairs. The top of the desk has two baskets, as usual, and a "waiting" card rack for sub-production orders not in work, a card indexed waiting tray in which Forms 8 are held during work, ink stands, pencil racks, etc. The desk has drawers to contain paper-covered, brass-fastener-secured books of Form 10, on which the component locations of principal orders are traced. Back of the chairs is a narrow railed-in space. The front of the desk is open to the shop floor, next the rail stands a "Tracer" cabinet, for holding the S K tracers, having as many grooved tray drawers as there are factory departments, each bearing on its front the department name.

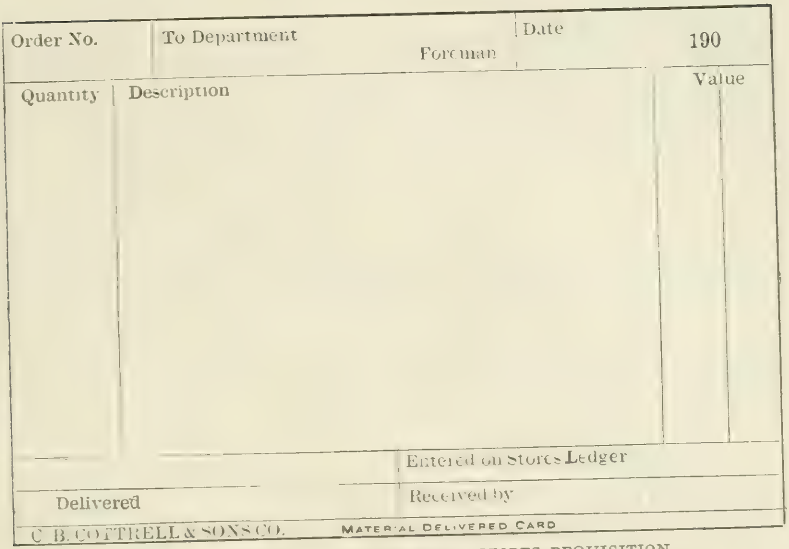
All regular production orders go to the transfer clerk. Repairs and S K orders are put in work without further instructions, the S K

CASTINGS

| No. | NAME | No. of Pieces | PAT. MARK | SECTION NUMBERS | DATE FINISHED |
|---|---|---|---|---|---|
| 1 | Side frame. R | | | | |
| 2 | " " L | | | | |
| 2½ | Rear tie, | | | | |
| 3 | Base. | | | | |
| 3½ | Front tie, | | | | |
| 4 | Track, | | | | |
| 4¼ | End piece, | | | | |
| 4½ | " " | | | | |
| 5 | Track support. | | | | |
| 6 | " " | | | | |
| 6½ | " " | | | | |
| 7 | " " | | | | |
| 7½ | " " | | | | |
| 8 | Yoke. | | | | |
| 9 | " box. | | | | |
| 9½ | " " cap. | | | | |
| 13 | Inside knuckle shaft bear., | | | | |
| 14 | Track supports, | | | | |
| 14½ | Bed rolls, | | | | |
| 15 | Bed roll stands, | | | | |
| 15½ | " " oil pan, | | | | |
| 16 | Rack hanger. | | | | |
| 17 | Air chamber, | | | | |
| 19 | Rocker shaft. | | | | |
| 20 | Bed. | | | | |
| 21 | Ink table. | | | | |
| 23 | Cam. conn., | | | | |
| 24 | Rocker shaft boxes, | | | | |
| 26 | Track caps, | | | | |
| 27 | Sliders, | | | | |
| 28 | Gibs. | | | | |
| 29 | Gib supports. | | | | |
| 32 | Feed guide brackets, R | | | | |
| 33 | " " " L | | | | |
| 34 | Vib rack shield, | | | | |
| 35 | Cylinder, | | | | |
| 36 | Cylinder shaft boxes, | | | | |
| 37½ | " " caps, | | | | |
| 38 | Lifting shaft collars, | | | | |
| 39 | Rack hanger guide, | | | | |
| 41 | Middle bear., | | | | |
| 42 | Bed shield. | | | | |
| 43 | " " | | | | |
| 50 | Feed table bracket, R | | | | |
| 51 | " " " L | | | | |
| 52 | " " standard. R | | | | |
| | | | | | |
| | | | | | |

FORM 10. PRINCIPAL ORDER TRACING AND LOCATING FORM.

Original is about 8 by 10 inches, ruled in red and blue. Kept in paper covers by transfer clerk, who records dates of movement of principal order components in "Section" number spaces. Finally sent to cost clerk. There is a similar form for forgings.



Order No. To Department Foreman Date 190

Quantity Description Value

Entered on Stores Ledger

Delivered Received by

C. B. COTTRELL & SONS CO. MATERIAL DELIVERED CARD

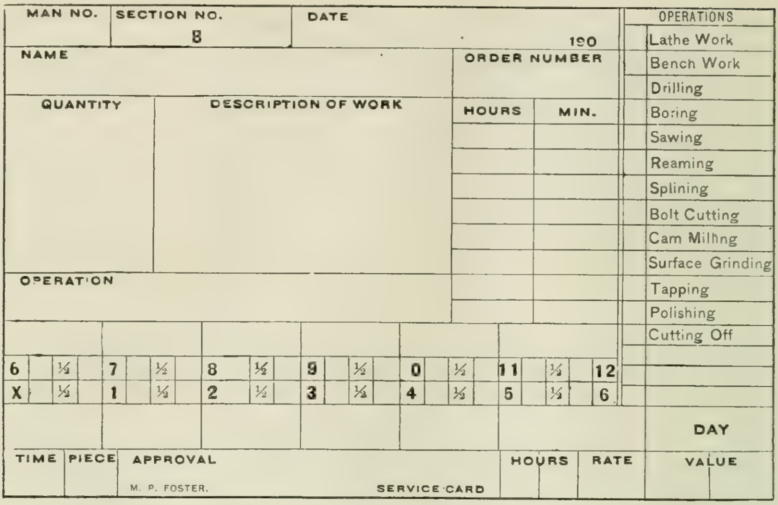
FORM 11. GENERAL DEPARTMENTAL STORES REQUISITION.

Original is 6 by 4 inches, printed and ruled in black on yellow paper. Honored by stores keeper, who fills value space if known to him; from him the card goes to cost clerk, who obtains other values from purchasing agent.

tracers being dated and placed in the first-operation department-tray grooves when the first operation begins.

Principal production orders are received by the transfer clerk when issued, and corresponding sub-production orders come to him as soon as filled by the production-order clerk, and are held until the order to put them in work is received, at which time the castings and forgings are supposed to be ready for machine work. The transfer clerk has already made out castings orders on Forms 9, which see, and now sends the castings and forging orders to the forge and foundry clerk, who marks the weight of each component on its sub-production order, and also notes the weight and symbol and order number on the daily list sheet of forgings or castings weights. Then the forgings and castings and their sub-orders go back to the transfer clerk who orders them delivered to their respective first-operation departments, and notes date of department entry on the Forms 10 sheet.

Tracing.—There are commonly about forty presses on the erecting floors, and it is the expectation to ship a press out of the factory every day. A single press may be made up of anywhere from 1,000 to 5,000 or 6,000 different components, which are carried through the factory in lots from 100 to 500 or 1,000, and there are always 10,000 or 15,000 lots of these components in process of production in the factory.



MAN NO.
SECTION NO. 8
DATE 190
NAME
ORDER NUMBER
QUANTITY
DESCRIPTION OF WORK
HOURS
MIN.
OPERATION

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | | ½ | 7 | | ½ | 8 | | ½ | 9 | | ½ | 0 | | ½ | 11 | ½ | 12 |
| X | | ½ | 1 | | ½ | 2 | | ½ | 3 | | ½ | 4 | | ½ | 5 | ½ | 6 |

TIME
PIECE
APPROVAL
M. P. FOSTER.
SERVICE CARD
HOURS
RATE
DAY
VALUE

OPERATIONS
Lathe Work
Bench Work
Drilling
Boring
Sawing
Reaming
Splining
Bolt Cutting
Cam Milling
Surface Grinding
Tapping
Polishing
Cutting Off

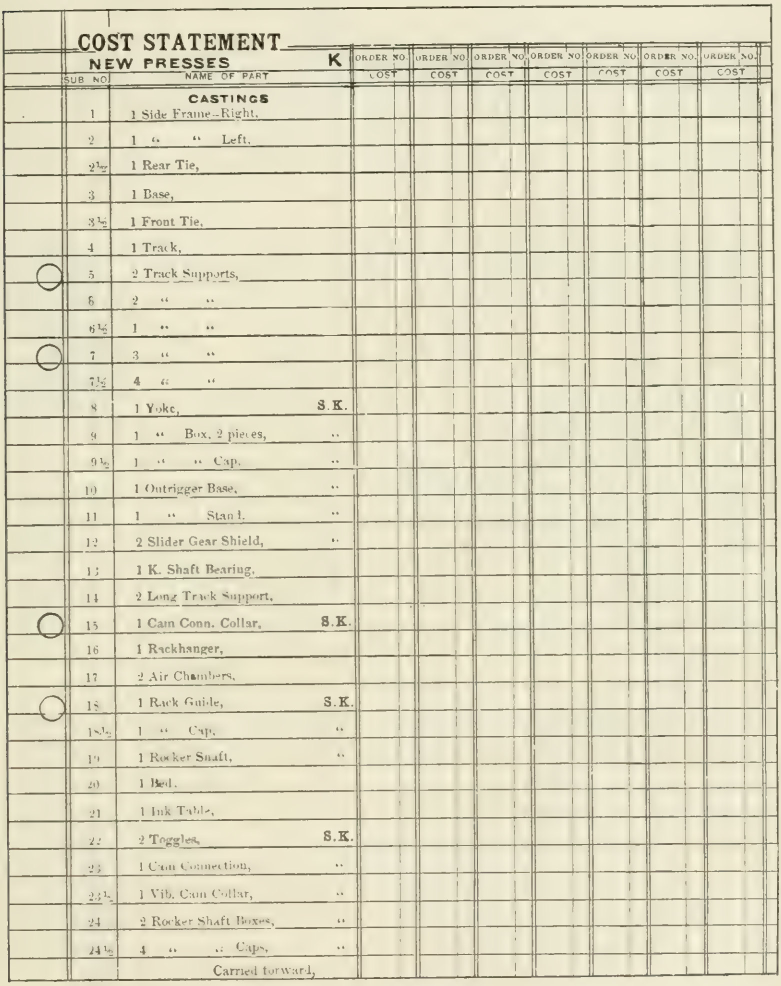
FORM 12. TIME CARD. DIFFERENT COLORS AND LISTS FOR DIFFERENT DEPARTMENTS.

Original is 6 by 4 inches. Printed and ruled in black on brown paper. Filled by workman and vised by foreman. Goes to paymaster and then to accountant.

It is absolutely necessary that three things should be always known of each individual factory production, great or small, simple or compound:—First, under what production order the component is produced, second, where the component is at any instant, third, what the state of progress is; this in regard to individual productions. In regard to principal productions, it is needful to know what components of each are completed, and in what state of progress the incomplete components are at any instant of inquiry.

No human mind could possibly remember the location of each one of the great number of components on the various department floors of the Cottrell shops, much less repeat correctly all of its time and location records, yet it is absolutely needful that all information in regard to every piece for which the head has called upon the factory, shall be accurately recorded from the time when its existence as a factory product begins.

S K Production-Order and Transfer Card and the Corresponding Tracer Handling.—The lack of the production order and transfer arrests a vagrant piece; consequently no unauthorized production is possible. It remains to locate the production by use of the tracer. When any department operations on any component are completed, the component must go to another department, to the erecting floor, to the stores room, or to the shipping department. It may of course remain where it is, but the department foreman must tell how he came to have it. The transfer clerk directs all movements of pieces of material in process of finishing from one department to another. When a piece is to change its location its transfer card must go to the transfer desk, where the transfer clerk directs its next location, and when a component changes location, this change is noted by the trans-



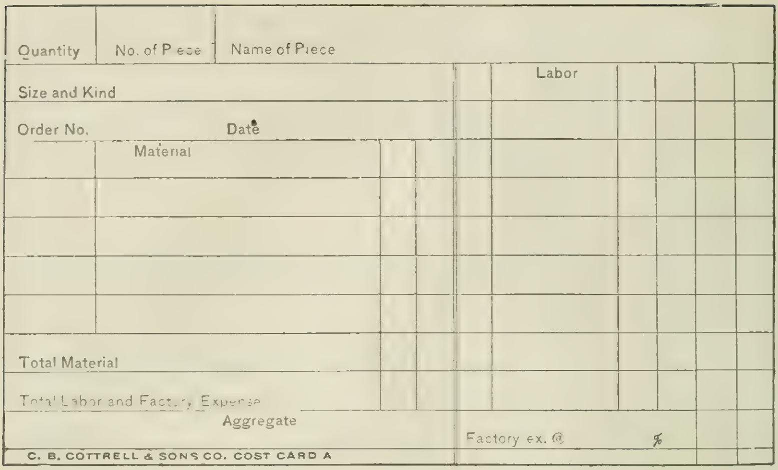
COST STATEMENT

NEW PRESSES K

| SUB NO | NAME OF PART | | ORDER NO.<br>COST | ORDER NO.<br>COST | ORDER NO.<br>COST | ORDER NO.<br>COST | ORDER NO.<br>COST | ORDER NO.<br>COST | ORDER NO.<br>COST |
|---|---|---|---|---|---|---|---|---|---|
| | CASTINGS | | | | | | | | |
| 1 | 1 Side Frame–Right, | | | | | | | | |
| 2 | 1 " " Left, | | | | | | | | |
| 2½ | 1 Rear Tie, | | | | | | | | |
| 3 | 1 Base, | | | | | | | | |
| 3½ | 1 Front Tie, | | | | | | | | |
| 4 | 1 Track, | | | | | | | | |
| 5 | 2 Track Supports, | | | | | | | | |
| 6 | 2 " " | | | | | | | | |
| 6½ | 1 " " | | | | | | | | |
| 7 | 3 " " | | | | | | | | |
| 7½ | 4 " " | | | | | | | | |
| 8 | 1 Yoke, | S.K. | | | | | | | |
| 9 | 1 " Box, 2 pieces, | " | | | | | | | |
| 9½ | 1 " " Cap, | " | | | | | | | |
| 10 | 1 Outrigger Base, | " | | | | | | | |
| 11 | 1 " Stand. | " | | | | | | | |
| 12 | 2 Slider Gear Shield, | " | | | | | | | |
| 13 | 1 K. Shaft Bearing, | | | | | | | | |
| 14 | 2 Long Track Support, | | | | | | | | |
| 15 | 1 Cam Conn. Collar, | S.K. | | | | | | | |
| 16 | 1 Rackhanger, | | | | | | | | |
| 17 | 2 Air Chambers, | | | | | | | | |
| 18 | 1 Rack Guide, | S.K. | | | | | | | |
| 18½ | 1 " Cap, | " | | | | | | | |
| 19 | 1 Rocker Shaft, | " | | | | | | | |
| 20 | 1 Bed, | | | | | | | | |
| 21 | 1 Ink Table, | | | | | | | | |
| 22 | 2 Toggles, | S.K. | | | | | | | |
| 23 | 1 Cam Connection, | " | | | | | | | |
| 23½ | 1 Vib. Cam Collar, | " | | | | | | | |
| 24 | 2 Rocker Shaft Boxes, | " | | | | | | | |
| 24½ | 4 " " Caps, | " | | | | | | | |
| | Carried forward, | | | | | | | | |

FORM 13. PRINCIPAL ORDER COMPONENT COSTS.

Original is about 8 by 10 inches, printed in black and ruled in red and blue on white paper. Margin perforated for binding. Similar list for forgings. Successive production costs shown on same line. Filled by cost keeper from Forms 7 and 14.



Quantity No. of Piece Name of Piece

Labor

Size and Kind

Order No. Date

Material

Total Material

Total Labor and Factory Expense

Aggregate

Factory ex. @ %

C. B. COTTRELL & SONS CO. COST CARD A

FORM 14. SPECIAL ORDER COST-SUMMARY CARD.

**Original is 5 by 3 inches, printed in black, ruled in black and blue, on a white card. Filled by cost keeper and filed by him.**

fer clerk on the corresponding tracer by noting on its back in pencil the date of transfer, and the location change is noted by moving the tracer from the last department tray occupied to the tray representing the department to which the component is to be taken. The front of the tracer bears the same order number and component symbol borne by the corresponding combined production-order and transfer card. Because no transfer can be made save by authority of the transfer clerk, he is always promptly informed of the completion of department operations on any piece in work. Hence the tracer tells all that need be known of the travels of the component, and as the transfer clerk must be familiar with all the work done, the department location and the date enable him to tell correctly the stage of finishing reached by the order.

Form 10 gives the department location and consequent state of progress of any component of a principal production order, and by means of this form or the tracers in the department tray cabinet, the transfer clerk can at any instant tell the present location and stage of progress of any piece in work, and the general condition as to forwardness of any principal order as a whole.

Both the production-order clerk and the transfer clerk are machinists, who had ten years' experience as factory workmen before they took their present positions.

# THE MANAGEMENT OF METALLIFEROUS MINES.

### *By Albert Williams, Jr.*

Mr. Williams has already reviewed the various widely differing kinds of metal mining and summarized suggestions as to a line of general policy applicable to the majority of cases. In this article he compares systems of organization and discusses the relations of the business and technical ends. A concluding section will take up in detail the efficient organization of the technical staff.—The Editors.

IN discussing the management of metalliferous mines it is assumed that there is something to manage; that is, that the mine has been found and partially or largely developed, that the property is of sufficient importance to warrant the employment of a considerable force, and that its business as a producer or prospective producer of ore and as a consumer of labor and supplies call for real management. In short, an establishment comparable with a factory, shop, or mill. What then should be the scheme of organization to secure greatest efficiency and smoothness of running?

To begin with, at the top is the owner, who may be an individual, a firm, a close corporation, or a stock company with shares variously held. In any event here is the source of authority, whether a person or a board of directors, standing over the actual superintendent, selecting him, and in a general way directing him, and deciding upon the broad policy of the undertaking. This central power may have been guided by the advice of a consulting engineer as to the purchase and outline plan of developing the property; but when once the enterprise is fairly under way it is better that the ownership should deal directly with the superintendent, and if it is found advisable to call in an outside specialist for an emergency the latter should assist, not interfere with, the superintendent, who must be supposed to be competent within inevitable limitation.

The question of the commercial policy of a mining enterprise need not be gone into in detail here, since it concerns the main office rather than that of the local manager; but it may be remarked that once decided upon it may strongly affect the technical running of the mine. The factors, in brief, which influence the decision are the state of the market, ore product and supplies, the transportation facilities (and season), the labor situation, available funds, etc. In gold mining there is of course no question as to marketing the product; with silver it depends upon the richness of the ore; but when it comes to the lower-priced products, such as copper, lead, zinc and more particularly iron ore, a great deal hinges upon the markets, the general condition of business in the country, and perhaps upon combinations to regulate or restrict output. All this should be made known to the superintendent, who is instructed to modify his scale of operations accordingly. The main office holding the purse strings also limits the superintendent's action, so that when working capital or reserve run short he may be forced to abandon some project which would be most desirable from the technical point of view and under other circumstances.

The proper relation of the home office to the superintendent is easily stated, is well understood and admitted—and is not always maintained in practice. In a board of directors there are likely to be one or more well-meaning, fussy persons who cannot restrain a desire to meddle with technical details of which they may have but a vague comprehension, and who evidence their zeal by frequent visits to the mine, where they make things pleasant by criticism and impracticable suggestions. The superintendent should be most carefully chosen, and when a good man has been secured he should be given a free hand as to details and especially as to his dealings with his subordinates, whether the staff or the men. Any other system is no system and is subversive of discipline. It would be like dropping a hammer head or piece of drill into a rock-breaker.

The home office should communicate freely and often, however, with the superintendent, giving him his instructions on broad lines, and it will be well if the relationship should be sufficiently confidential to enable the superintendent thoroughly to grasp the financial situation and to foresee and to provide for changes of policy. If he were always posted in advance as to matters of dividends, assessments, issues of bonds or new stock, amount of reserve and working capital, etc., he could act intelligently; but such confidence is too much to expect always.

Thus far the terms superintendent and manager have been used interchangeably. Strictly speaking, they are not synonyms, but are often loosely used as such. The American idea of a superintendent is the man on the spot who bosses the whole job, who attends both to the working of the mine and all its adjuncts (metallurgical, transportation, etc.) and to the business side as well. He is an evolution from small beginnings, and under existing expansion is sometimes overweighted by his work. It would be highly advantageous if all the multifarious functions of a great establishment could be centered in a single head, and so far as is practicable this is usually done in the United States. It has been found expedient, however, sometimes to divide the responsibilities. The authority must be unimpaired. Thus at some mines in the United States, and at most British-owned mines elsewhere, there is a manager, agent, or managing director who attends to the local business and who outranks the man who actually runs the mine. The latter official then becomes a "mine captain," a sort of glorified foreman, and he is the one with the technical skill and experience. A dual headship, putting the two on equal rating, has been tried. It could hardly be expected to work. Now it is obviously a delicate relationship at the best between these two men, and a clear understanding and mutual forbearance are needed to maintain harmony; so that it is well that the final say should remain undisputed, to avoid a clash. There is nothing to prevent the agent or manager from being a true mining man, and, if so, so much the better; yet this is not indispensable. A wholesale confectioner has made a very good mine manager, and there are agents who do not go underground once in weeks or months, while the captain looks out for that end.

There is an alternative plan which is adopted at some mines. The superintendent—the miner—remains at the head, but has a trustworthy man who elsewhere would be called a business manager and who is a cross between purchasing agent, accountant, and secretary, and is given considerable latitude of action, thus allowing more time to the superintendent for directing the mining operations. This is practically a reversal of the previous plan, but retains the idea of single headship, and should work well wherever the mining problem is difficult or the business moderately extensive. One may be, and often is, an excellent miner without being a good business man. What is wanted is a definite adjustment of responsibility and authority.

The relation of the superintendent to the home office is reciprocal to that of the home office to him, as already explained. He usually makes a formal weekly report of the operations of the week just ended. This shows the following among other items:—tons of ore raised; tons of waste; tons of ore milled, concentrated, shipped, etc., as the case may be; average assays of ore mined and of ore shipped or otherwise treated; number of feet sunk or raised, feet of shaft, incline or winze timbered; feet driven; feet of levels, cross cuts, drifts, etc., timbered; assays from face of drifts, bottoms of mines, head of upraises, breast of stopes, etc.; number of men employed in various departments; condition of the mine at all points; requisitions for money and supplies, etc. Part of this can be conveniently entered on printed forms; part will be written out succinctly and simply. If there is a metallurgical plant, its report (for which another set of forms might be prepared) is incorporated in the regular weekly statement. The business report is made up and forwarded monthly, and follows a set form in part, for convenience of comparison with former months and summarizing. This gives the pay-roll, receipts, expenditures (itemized and grouped) for salaries, labor, supplies, transportation, etc., together with explanations written out. This report should be in such shape as to fit in with the system of bookkeeping at the main office, and also to work readily into the quarterly and annual balance sheets. If the company publishes an annual report, the superintendent's annual summary is a leading feature, following the financial statement; it should show average costs, and is designed to make clear to the shareholders without unnecessary technicalities just what has been done at the mine and works during the year. Even with private ownership or that of a close corporation, these formal reports, however brief, are useful. Besides the regular statements the superintendent should promptly report emergencies and should always clearly explain the local situation, outlook, and requirements, making suggestions for future work needing approval, and when in doubt getting authority to carry plans into effect. For large mines telegraphic or long-distance telephone communication is a great convenience and time saver.

The relation of the superintendent to his subordinates should also be perfectly distinct and well understood on all sides. Only a mine of considerable importance can maintain an expert staff. If there is one, it may comprise an assistant superintendent, surveyor, metallurgist, assayer, electrician, machinist, surface and underground foremen, as the case may be. The superintendent should cultivate friendly relations with his junior officers and among themselves. In isolated camps they usually mess together and are all thrown into such intimate daily contact that good temper is worth having. The superintendent should maintain authority with the least friction and arbitrariness, and should encourage and be ready to approve and apply useful suggestions, interfering as little as possible with the details of their work. The amount of expert assistance which the superintendent or manager receives depends upon what the mine can afford rather than what he would like to have or might really need, for it would be almost as absurd to overload the enterprise with a heavy salary roll at the mine as with one at the home office—not quite, though. Much rests upon the prosperity of the undertaking or the probability of making it prosperous, and upon the scale. It would be easy to eat up in salaries the margin of profit of a moderately successful mine.

Towards the hands, the relation of the superintendent is direct and personal at small and medium mines; at large ones he acts through his immediate subordinates, and in this case the order of authority and responsibility passes downward without interruption. Mine discipline is just as important as military discipline, but in its outward aspect is a very different matter. Nothing of the martinet is permissible in a mine superintendent or any other mine officer. Even a certain degree of familiarity is allowable without risk of relaxing rules, and American miners would resent any offishness. Orders should be given with considerateness, but enforced strictly, since prompt obedience is of prime importance in the ever-recurring sudden exigencies of mining. For infraction of rules there is only one penalty—discharge. Consequently the rules should be sensible, easily intelligible, as few and as little irritating as possible. Those designed to prevent or lessen the danger of accident are the ones upon which the most stress should be laid; and though the risks in metal mines differ in some respects from those in collieries (explosions of gas and dust being eliminated, also suffocating gases usually), they are scarcely less imminent and call for equal precaution.

While what has been termed the commercial policy of a mining enterprise must be determined by the owner or central office, subject to the fluctuations of the markets in some instances, and to available capital in all, much is left to the discretion of the superintendent or local manager in deciding upon a plan of campaign, to say nothing of measures which he may recommend but cannot carry into effect without authorization. In his advisory capacity he has to bear a large share of the responsibility for what is done, since the owner or directors necessarily rely upon his experience and skill; besides which, being on the ground, he is in a better position to realize the situation and is expected to formulate and submit plans for all important work.

This is not a treatise on the art of mining, but a few suggestions of general applicability may be in order.

For one thing, it must be remembered that prospecting never ends, or never should end, until the mine is fully explored or finally abandoned. It is assumed that before acquiring a property and starting serious work a certain amount of prospecting and development has been done, enough at any rate to justify purchase of the ground and the opening of a mine. This preliminary work would be intended to serve as a guide for the laying out of the underground workings. But even after a shaft or shafts have been sunk or adits run, up to the time when the full extent of the territory has been explored underground, the surface prospecting should go on. Trenches and shallow pits, which are inexpensive, should be put in at rather close intervals along the line of outcrop (if there is one), and these may furnish clews to the location and direction of ore shoots which are then drifted for below ground. With bedded or segregated deposits the diamond drill, started most conveniently at the surface, may save much dead work below. Underground prospecting is perhaps the most important and the crucial test of mining. It is an art in itself, and the method followed is modified by geological and local conditions. In general, there are two main systems of underground exploration:—

(1) Blocking out the ground between levels and connecting them with raises or winzes at regular intervals, and running cross-cuts, also spaced, right and left on each level as far as probabilities warrant. These blocks of ground are usually spaced at intervals of 100 feet vertically and 200 feet in drifts, the purpose being not to miss any large ore body. Within these distances any feeders, stringers, or knife edges would almost certainly be caught.

(2) Following "indications," as for example, index seams along one wall or the other, small stringers and feeders of ore, traces of gangue minerals, iron stains, water channels, cross courses, etc.

The core drill is also available underground, but has not much range horizontally and on flat dips. At any rate the selection of ground for stoping should in large bodies be regulated by the results of this exploratory work. In small, irregular, and high-grade deposits, however, the usual plan is to follow the ore if there is any, Mexican fashion; and when the ore gives out, to follow whatever signs there are. This exploration should be kept well in advance of the process of extraction. Too much stress can hardly be laid upon the importance of constant sampling, assaying, and testing, whenever the face is in anything like ore, however poor. In this way the underground prospecting is guided, and of course the stoping.

It is impossible to say in short compass anything worth attention as to the exact plan of attack in starting new openings from the surface. Each case must be judged by itself. It may be remarked, however, that the trend of recent practice has been in favor of vertical shafts where formerly slopes (inclines) or tunnels would have been preferred. Better hoisting machinery, cheaper fuel (where railroad connections have been made), and the advantage of bottoming a deposit and working from the deep, account in part for the change in opinion about what might have been mooted cases of shaft *versus* tunnel a few years ago, but the readier securing of capital in the present temper of investors has something to do with it; while as regards shaft *versus* slope the latter is now seldom adopted on very steep dips. In the earlier days of metal mining the permanent workings were usually extensions of preliminary prospecting pits and tunnels, but now it is a common thing to see a mine opened systematically from the outset, provided there is a known ore body or there is reason to believe from the "lay" of adjoining properties that one exists.

The selection of plant hinges upon the system of development. There is now no excuse for ordering the wrong *sort* of machinery to fit a given state of affairs, for in all lines (steam, compressed air, electric, or hydraulic) mining and metallurgical machinery has been brought to a pitch of efficiency which leaves little to be desired. The great difficulty is to gauge the proper *extent* of the plant, to get enough to do the work and not to overdo it. The conservative plan is to begin with moderation and allow for expansion later, even if some temporary apparatus has to be discarded; for example, to start sinking with a horse-whim or donkey engine, to plan mill buildings with a view to convenient extension, to make the first installation if possible a unit-group for later complete output, and in proportioning motive power to operating machines to give an overplus margin to the power end. Besides this, in determining the kind and extent of mechanical plant, the manager is guided by results of installations under conditions similar to those he is called upon to meet. In the present stage of progress there is less and less scope for originality and novelty of design, the field having been pretty well worked over, so that conservatism rather than experiment is the prevailing policy. All mining men will recall the case of a famous mine so rich that it seemed as though nothing could hurt it and a certain amount of monkeying with untried methods and machinery might possibly be excusable, which has spent some millions in showing its neighbors how not to do things; but the careful manager will make it a rule to allow some public-spirited establishment which can afford it to make these experiments first—and then profit by experience. This does not sound very enterprising, but the plan is at least safe. Once in a while a new problem comes up, the solution of which can be worked out and proved in the draughting room, but most of the substantial progress has been made by gradual modifications and improvements in well-tried methods, startling innovations being rare. A manager gets no end of credit for a bold move which succeeds, but he is restrained by the risk of disappointment. Here is opportunity for the exercise of a nice balancing judgment in maintaining progressiveness and standing ready to adopt new methods with an open mind, without running into extravagance, and in steering a middle course between rashness on the one hand and old-fogyism on the other.

The manager has also to proportion the scale of operations and the labor roster to the kind of mine in hand. Some mines will not hold a large force; for even with many working faces there is not a wide enough ore body for regular stopes. Then there are large low-grade deposits which cannot possibly be made to pay if worked on a small scale, fixed charges using up what little margin there might be, besides self-evident disadvantages. In such cases the wholesale method is the only one practicable, but should be undertaken only after a thorough study of all the conditions.

In small mines it should be the aim of the superintendent to make what would otherwise be dead work pay for itself or reduce its cost, by utilizing the leaders, even if they run out into the "country." This, again, is the Mexican idea, as opposed to the engineering principle. For narrow, uncertain veins and segregated deposits it is right to block out the ground; for regular veins the other system is better.

Speed is often economy. Certain charges are continuous, such as salaries, pumping, interest on investment, deterioration of plant and timbering, etc. A point too often overlooked is that the ore itself should be regarded as so much idle capital, drawing no interest. So the sooner it is gotten out the better, even if it costs a little more per unit to rush extraction. A mine is an exhaustible quantity, and thus differs from an establishment which may be kept going indefinitely. Hence, if there is a given quantity of ore in the ground, provided there is a fair market, it is preferable to get it all out in a couple of years at a nominally higher unit cost than in twenty years.

The ore may be regarded as only one of the raw materials. Sometimes it is expedient to sacrifice close technical results in order to save in the direction of supplies and other cost items—a hard strain upon professional pride.

Everyone realizes the importance of keeping the dead work well ahead of the stopes and of blocking out and measuring, or at least locating, ore reserves, but for reasons of temporary expediency this is too seldom done. To insure steady running of the mill, if there is one, or to maintain regular shipments, the ore dumps or bins should be kept up. Where transportation is shut off in winter the extraction of ore should go on, to accumulate a sufficient stock ready for the opening of the next season. Good mining reserves the backs for the last, for the period just prior to the mine's abandonment.

Finally, this inadequate review of a very complicated and perplexing theme leads up to the inquiry, What of the man who is to attend to all this? If one is too finnicky in cataloguing the requirements, only an angel—and an angel of wide experience—would fill the bill. As humanity never concentrates all the virtues in one individual, the best that can be expected is to obtain some at least of the needed attributes and avoid as many as may be of the drawbacks.

As to character and temperament, the manager or superintendent should be energetic, prompt in decision, self-reliant, watchful, ready of resource, conservative without being afraid of big undertakings, broad-minded, willing to learn, and should possess executive ability and have a knowledge of men and affairs. As to acquirements he should have a fair all-round comprehension of all the technical work involved. Mining, besides the "practical" side—to use a much abused term which generally means putting in shots, setting timbers, blacksmithing, and guessing at other things—rests upon economic geology, which in turn is based on mineralogy, lithology, physics, etc.; metallurgy is founded on chemistry and assaying, physics, and mineralogy. Then civil engineering (road and bridge building, etc.), surveying (surface and underground, transit, level, or compass and tape, and draughting) comes into play. Mechanical engineering (including steam, pneumatic, hydraulic and electrical engineering) is often a requisite. Then even his manner counts; it should combine business with tact. No one man has all these faculties but some seem exactly fitted for managing a particular kind of mine, others for a different sort, and a few (given sufficient time) would get along anywhere.

There is no longer a prejudice against the technical schools and "booklarnin'." The self-taught successful superintendents would have saved much of time and misdirected effort by a preliminary grounding, and in the end have become even better miners. But the young graduate of the mining school needs considerable experience and rubbing down before essaying the responsibilities of superintendence. He should begin as an assistant, as mine surveyor, assayer, or foreman of some department.

# THE COMMERCIAL MANAGEMENT OF FACTORIES.

*By Ian Andrews.*

Mr. Arnold's article preceding is addressed especially to the shop manager. Mr. Andrews speaks more directly to the office manager, who deals with general policies and commercial affairs in which the shop costs are but one element, though a very important one. He takes the matter up at the point where the preceding writer leaves it. The paper following considers the managing director's relations to general works organisation. A following one will analyse his relations to cost reduction.—The Editors.

IN this article I propose to deal more particularly with the commercial or financial aspect of the management of factories, as distinct from the practical side of manufacture—although, in a sense the one is as practical a subject as the other. I shall therefore aim to epitomise a few of the leading principles of successful management. For this purpose, the subject is viewed from the standpoint of the managing director, who, having efficient departmental managers and foremen devoting close attention to the best means of production, exercises a guiding control of the business generally.

Reference is made particularly to the manufacturing businesses of joint stock concerns, of which there are now so many; but the remarks apply generally to similar proprietary businesses, for the aim of both is a fair maximum of profit. We hear a good deal of the want of soul in business corporations, but it must be admitted that, having to satisfy a large body of shareholders, they have as great an incentive as private owners to proceed on sound economic lines.

The subject may be conveniently considered in the following order:—(1) Capital (2) Cost of production (3) Working expenses.

Capital.—The amount of capital employed should not exceed that safe minimum necessary for the efficient and economical working of the business, as superfluous capital can only entail loss of interest, if not more serious consequences.

Fixed capital, consisting of buildings, machinery, plant, etc., being subject to depreciation, should be written down periodically, and there should be no division of profits without first making a safe provision for this important item in regard to all wasting assets. All repairs and maintenance should be scrupulously charged to revenue, or against reserves previously created for the purpose.

The rate of depreciation will necessarily vary, according to circumstances in different and even in similar businesses, and, as deductions for depreciation are more or less estimates, it is wiser to err on the safe side than to make an insufficient provision.

The probable lifetime of each item of capital which is subject to deterioration is generally the basis of depreciation, although this is not always a safe one, even with former experience as a guide; this is especially true in the case of machinery.

There are many firms today using machinery of an antiquated type, the output capacity of which is only a fraction of that of modern labour-saving machinery: but because the normal lifetime of their plant has not been reached, they will not discard it, oblivious of, or indifferent to, the fact that their policy is "penny wise and pound foolish." They therefore continue to deduct say 5 or 10 per cent. per annum, but would find it infinitely more profitable to write off 100 per cent. from the book value (less its scrap value if it cannot be otherwise disposed of) and to instal modern plant forthwith. Many successful concerns, however, appreciate this fact, and will throw machinery on the scrap-heap, or sell it, long before its natural life has expired, simply because of its inefficiency as compared with later inventions.

Paper assets or "watered capital," such as goodwill and Suspense Accounts, should be most carefully scrutinised, as they very frequently account for the over capitalisation of a business and lead to disastrous results. Occasionally the price paid for the goodwill of a business may be allowed to stand in the balance sheet at the original figure, because of the permanent or increasing value of the business; but even then there should be a substantial periodical provision, in the shape of contributions from profits, to a special reserve fund, to meet any unexpected diminution in value. A reserve fund is usually established as a provision for the equalisation of dividends, but this in itself is insuffiicient, for when the time comes to draw on such reserve to make up a deficit in profits, it means that the goodwill is, for the time being at least, of less value; and should there be repeated recourse to the dividend reserve fund, the value of the goodwill as a matter of course automatically shrinks. If, when the goodwill figure was originally a fair value, such a provision is desirable, it is all the more necessary when too large a sum has been paid for it. In such a case, indeed, it is fallacious to maintain the original figure as an asset even though a reserve appears on the other side of the account. It should be written down to its true value without delay, even if it has to be extinguished, in which case the goodwill reserve would disappear.

Having created reserves for such contingencies and for others likely to arise, it becomes a question as to whether the money should be invested in the business, or outside of it in the shape of securities. Theoretically a reserve should be readily available for the purpose intended, and if likely to be required on short notice, it cannot safely be locked up in the company's own business. Not infrequently, however, reserve funds are more profitably employed inside the business than they could be outside. For example, money safely invested outside may not yield more than 3 per cent. per annum, while additional capital cannot usually be obtained except at a higher rate. In the case of debentures, 4 per cent. or 5 per cent. may have to be paid, while if the company has no further borrowing powers, additional capital raised by the issue of shares may absorb a larger rate for dividend. As to the investment of reserve, circumstances must guide particular cases; but whatever form of investment is adopted, the first consideration is to set aside a sufficient part of the profits in order to strengthen the business, so that it may have a good reputation with its customers, creditors, and the investing public; for nothing is more damaging to success than doubt as to a company's stability, even when it is selling an article for which there is a popular demand.

We now come to the consideration of stocks—raw and manufactured—which form a most important item in regard to capital; in a large concern having a multiplicity of goods the most constant supervision of this fluctuating asset is absolutely necessary.

In the first place, it is highly essential that adequate stocks be kept, so as to ensure prompt execution of orders. If a business has a reputation for quick dispatch, it will go far in the direction of maintaining the value of the goodwill. No dilatoriness in the execution of orders should be tolerated, and periodical lists of unexecuted orders, with explanations for delay, should be submitted to the manager for inspection, so that he may take the necessary steps to rectify matters before the customers are compelled to make complaints. And in this connection it may be said that overtime, although not generally profitable, should, if necessary, be resorted to in order to cope with arrears, rather than to give customers cause for dissatisfaction.

The mistake in regard to stock-keeping, however, not infrequently lies in having excess stocks, and it is in obviating this that a good store keeper has an opportunity of showing his value. General experience goes to prove that where there is a large variety of raw and manufactured goods, unless a complete system of stock keeping is adopted and carried out, overstocking almost certainly follows.

There should be, in the first instance, properly constructed departmental stores—preferably situated near the respective classes of workers using them, so as to minimise the cost of handling. In these stores there should be a specific place for everything, as by this means obsolete stocks are discovered and weeded out. Each compartment or bin should be numbered and labelled as to its contents; a reference index or catalogue should be available, and maximum and minimum stocks of each article should be determined in the light of past experience, due regard being given to any increasing demand and to the fact that when large quantities of small articles can be bought or produced at proportionately cheaper rates than small quantities, larger stocks of such articles may sometimes be judiciously allowed. A record of all store receipts and deliveries should be kept, so that the store keeper may always know the position of stocks and take steps to replenish them. Circumstances will determine how far it will pay to carry out such a system in small factories, but generally speaking, there can be no doubt of the advantages of as complete a system as possible, especially in large works. A test check should be made from time to time, in order to ascertain how far the stock keeper is following instructions, and the accounts when made up at the date of stock taking will show the result in the aggregate.

It is not enough to find that the amount of stock does not materially alter at the different dates of stock taking. The stock on hand on such occasions, should be worked out on the percentage principle, in some such manner as the following:—

Manufacturing account for the year ending ....................

(EXAMPLE.)

| | | |
|---|---|---|
| By sales | | £250,000 |
| To stock from last account | £55,000 | |
| " materials purchased | 110,000 | |
| " wages paid | 95,000 | |
| | £260,000 | |
| Less stock on hand | 65,000 | £195,000 |
| Gross manufacturing profit | | £55,000 |

From such an account the following percentages would be deduced:—

Stock on hand (£65,000) is equal to

(1) 33 1/3 per cent. of the manufacturing cost (£195,000) of the year's turnover.

(2) 26 per cent. of the turnover.

From the first of these it would appear that the stock on hand is equal to four months' requirements (*i. e.,* 33 1-3 per cent. of twelve months) taking the stock as a whole. There may not be four months' stock of certain articles, while of others there may be sufficient for the requirements of a much longer period, but the figures show the average stock held. These figures are of course assumed without regard to due proportions, but as to this, all proportions must vary according to the nature and circumstances of the business. Those in charge are the best judges as to whether it is necessary to hold one, two, four or six months' stock, but quite apart from any opinion or knowledge on the subject, each year's comparative figures will be the best guide to a manager, who, having to rely on subordinates to some extent, may yet by his bird's-eye view discover what others fail to see.

It will be observed from the figures assumed, that during the financial year, the stock had increased by £10,000, or say 18 per cent. This on first sight might appear an alarming increase. If, however, the previous years' accounts were similarly analysed, the true position could be readily ascertained. If the business was a progressive one, the percentages might show that, although the aggregate of stock is considerable, its relation to turnover is quite satisfactory. If, however, stocks were found to bear an increasing relation to the cost of manufacture of the year's turnover, there would be a grave need to investigate fully the reasons for the upward tendency.

The percentage of stock on the year's turnover is also a useful figure for comparison, although in this case it may be affected by fluctuations in the selling price of the goods. In the case of businesses having branch establishments there is frequently a considerable amount of stock in excess of the amount which would be required, if the business was worked from one common centre, but as the object of branches is to secure local trade, which could not (to the same extent) be otherwise obtained, this excess may be unavoidable. Yet by judicious management, the departmental stocks can be minimised.

While on the question of stocks, it may be remarked that in pricing inventories of manufactured stock, only the bare cost of production should be taken, exclusive of any percentage for working expenses. It is sometimes argued that such stock could not have been produced without certain establishment charges being incurred. but it is difficult to maintain that such charges would have been materially lessened if the stock on hand had not been manufactured. In the event of the business being wound up, the cost of realising the stock on hand in the ordinary way of trade, would absorb further charges, and even should the business be sold as a going concern, the stock would probably be taken at bare cost only, while if disposed of by forced sale, much less than cost would be realised.

Some factories having branches manufacture for and sell to their branches at a price which includes an assumed profit, or at least a margin for working expenses. This price is charged in order to show the comparative results of each branch, but when manufactured goods are debited to a branch at a price beyond cost, a fictitious profit is brought out if the branch should include any of such goods on hand at the advanced price in their stock inventory at the end of the year. The more satisfactory method is to charge all transfers at bare cost, and at the end of the year, to prepare a memorandum departmental Trading Account, supplemental to the ordinary Trading Account, in which an allowance for working expenses may be made.

Before leaving the question of capital, the item of patterns should be mentioned. In many businesses, patterns have to be made for special orders and may not be again required, in which case the cost is not a capital charge but a revenue one, being recovered in the selling price of the manufactured article. When, however, similar articles are being constantly reproduced from regular patterns, the cost of such patterns may be fairly charged to capital, but it should be liberally depreciated from time to time, to meet the heavy wear and tear on patterns and to provide against the possibility of their becoming obsolete before they are worn out.

In order to preserve the capital intact, buildings, machinery, plant and stocks, as also goods held in trust for which the manufacturer may be held responsible (such as goods received for repair, etc.), must of course be fully insured against the risk of fire. In the case of factories having a number of separate compartments or buildings, between which stocks are constantly passing to and fro, it is an expensive matter to insure the stock in each building for separate sums, because it is always desirable to have a margin on each for any possible increase that may arise during the year, especially as the inventory values forming the basis of insurance may not fully represent the value of stock at the busiest period of the year. These margins would amount in the aggregate to considerably more than would be sufficient as a margin if the whole stock was insured in one sum. To obviate this, however, the stock throughout the works can be insured for one sum, subject to the "average clause," which will in no event adversely affect the insured so long as the total stock is fully covered. Loss of profit from a temporary cessation of business through fire, and the rent of temporary premises used while the buildings damaged by fire are being repaired, are also insurable interests.

Needless to say, fire insurance should be supplemented, by the employment of night and day watchmen. It is also desirable to have fire appliances throughout the works and to train a number of employees in their use.

While an inflated capital is an evil to be avoided, it will be evident that insufficient capital is also a source of danger and loss. The amount of liquid capital necessary will depend upon (among other things) the nature of the goods manufactured, the turnover and output, and the facilities for obtaining raw material on reasonable credit. When labour, requiring as it does ready money for wages, forms a considerable proportion of the cost of the manufactured article, the liquid capital required will be necessarily high, especially if the output be large; and as that output increases, further capital will be required to pay additional wages, and to provide larger stocks to keep pace with the increased demand.

The command of capital enables a manufacturer to buy to the best advantage, and consequently to undersell those who are compelled to buy on long credit. When, however, capital is limited, it may be advantageous for the purpose of buying at the lowest cash price to trade on borrowed money, to a limited extent—if the cost is not excessive and the arrangements for repayment are not such as would involve the borrower in sudden difficulties.

When manufacturers have no facilities for, or are averse to, borrowing, they may have recourse to bills of exchange, which will give them similar advantages at rather less cost, although the liability thereon will, in a sense, be greater, by their having to provide for the certain payment of their acceptances as they mature. With limited capital, bills, besides providing the means of reducing the cost of credit, are frequently serviceable, if indeed not really necessary, as when raw material or goods have to be paid for before they can be manufactured and sold, and, when sold, the price is not obtainable for a further period—although in this latter case bills drawn on the purchaser would provide funds. Bill transactions cannot, however, be safely carried on without a margin of liquid capital.

If capital is to be kept down, strict attention must be paid to the systematic collection of accounts as they fall due. Book debts are too often allowed to run on, without consideration of the loss of interest incurred and of the capital unnecessarily locked up.

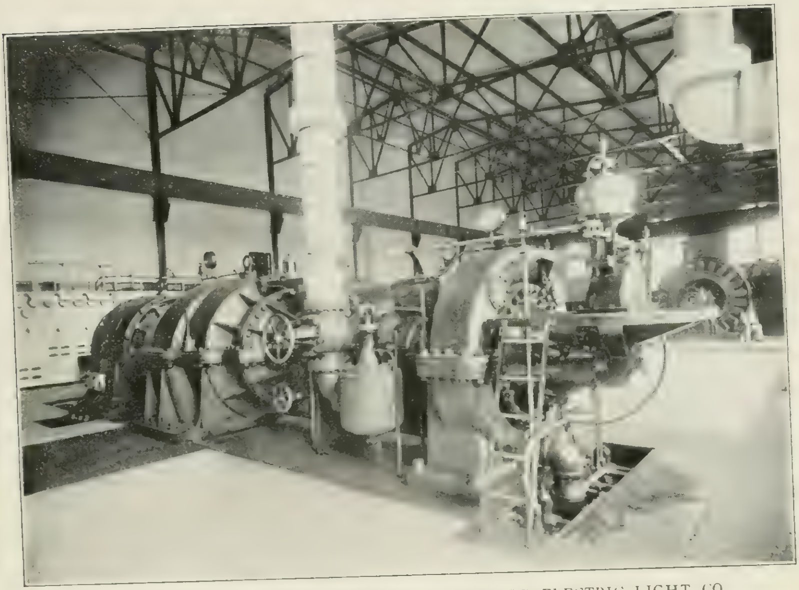
# PROGRESS IN THE INTRODUCTION OF THE STEAM TURBINE.

*By J. R. Bibbins.*

THE steam turbine has to-day reached a state of mechanical excellence and commercial importance nothing short of remarkable, when compared with the development of other types of prime movers, such as the reciprocating steam engine and the gas engine. This rapid development has however been apparent only within a comparatively few years—less than a decade—the period previous to this being one in which ideas regarding proper turbine construction were being crystalized and put into practical shape. The chronology of the steam turbine is interesting, as indicating the unequal and erratic progress which may be made in the various branches of the mechanical arts, as well as the anticipation of modern by ancient inventive genius. The reaction turbine dates back to the time of Hero, and his contemporary, Archimedes, 120 B. C., and was treated in Hero's celebrated work, "Spiritalia Seu Pneumatica." The impulse type is credited to Branca, who brought out his invention in 1629. Less than a century later, in 1705, the reciprocating engine appeared, from which time this branch of steam engineering has received the almost undivided attention of steam engineers. In 1884, Parsons brought out the first turbine of the multiple-expansion type, combining in principle the fundamental features of both impulse and reaction types; this was a double-cylinder, or so called "compound" machine, with steam entering at the center and expanding in opposite directions, thereby balancing the opposite thrusts due to the impinging steam. This turbine ran at 18,000 revolutions, driving the generator for lighting the Tyne steamer Earl Percy.

In 1883 was introduced the original form of DeLaval turbine, a form closely approximating the Hero, or reaction type, and one subsequently employed in centrifugal cream separators. The modern type of DeLaval turbine did not appear until 1889; it is a noticeable fact that the original design has since been departed from in minor details only. In 1894 the trial runs of the celebrated 2,000-horse-power yacht Turbinia brought to light the unexpected marine phenomenon of "cavitation," followed in 1899 by the record run of the ill-fated Viper, 37.1 knots, or 43 statute miles per hour. The Viper was 210 feet long, 21 feet beam, and her displacement was 350 tons. The aggregate capacity of her turbine equipment was 16,000 horse power, an astonishing figure for a boat of such small dimensions. The Viper was equipped with eight propellers, running at 1,200 revolutions. The Cobra, a sister destroyer of somewhat less displacement, was equipped with an 11,500-horse-power turbine outfit, and attained a speed of 35.6 knots. Both ships were, however, of too frail construction and were lost after a short period of service. In spite of these disasters, which were in no manner due to faulty turbine construction, a third-class cruiser and a number of new destroyers are being equipped with turbines, notable among these being the Velox, Eden, and the Amethyst, the first of which has already made 33.64 knots during an unofficial trial trip in September, 1902. Two Clyde passenger steamers, the King Edward and Queen Alexandra, have recently been put into service and are propelled by Parsons turbine equipment aggregating 3,500 horse power per vessel. These boats have already made record runs of 20.48 and 21.63 knots respectively.

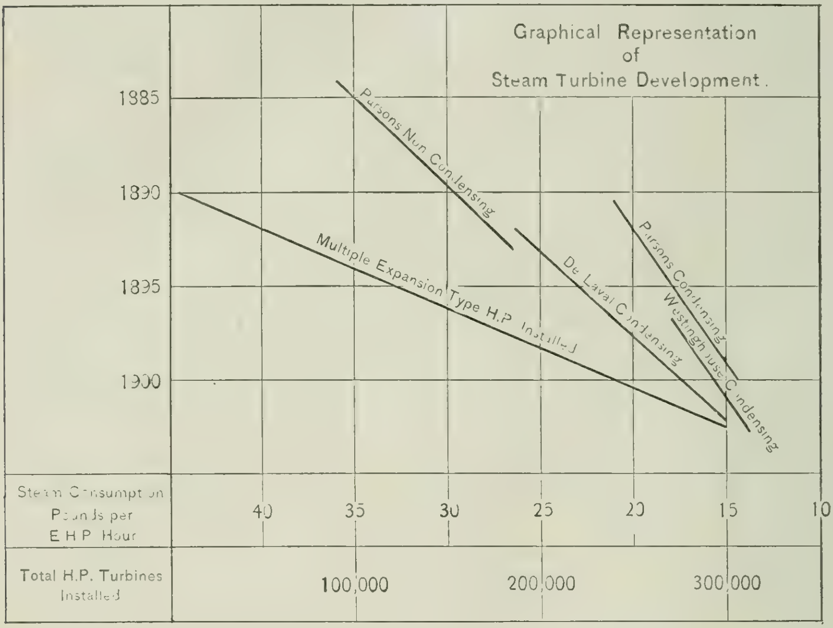
During the period between the introduction of the Parsons marine turbine and the beginning of the present century, this type underwent extensive improvement with the result that it was finally conceded to be the most practical form of the steam turbine, and one most susceptible to future development. Manufacturing rights for special application to power work in America were ultimately acquired by the Westinghouse Machine Co. This company has since completely re-designed the original machine, discarding many features and introducing others which would improve the already remarkable economy. In 1899 the first American turbine installation was put into service at the works of the Westinghouse Air Brake Co., at Wilmerding, Pa., which in connection with a polyphase power-distribution system entirely replaced the original steam-power system of the works. This change in power distribution resulted in a net saving of approximately 36 per cent. in fuel alone, part of which was of course traceable to the more efficient polyphase system. The most recent American turbine installation is that at Hartford, Conn., which has lately excited so much interest on account of the size of the unit and the results secured; the capacity of this turbine is approximately 1,500 kilowatts, or 2,000 horse power, and it is the largest in use in America at the



1,500 KILOWATT TURBO-GENERATOR, HARTFORD ELECTRIC LIGHT CO.

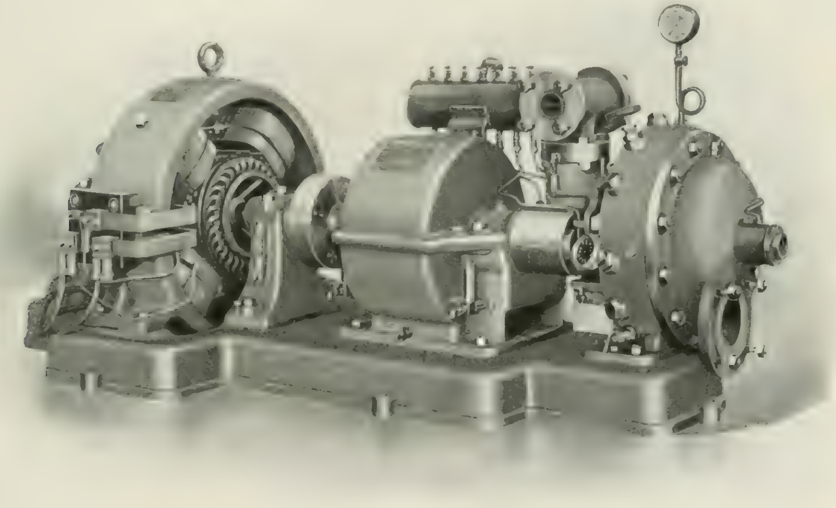
present time. A number of turbines of from 1,000 to 5,000 kilowatts capacity are, however, under construction by the Westinghouse Machine Co., both for export and domestic use. It is somewhat significant that the largest of these machines comprising two equipments, aggregating 30,000 kilowatts, will go to England, which has been the seat of development of this type of steam turbine from its inception.

Much progress has also been made in Europe with the steam turbine as applied to power as well as marine work. Turbines of 1,000-kilowatts capacity have already been built and put into operation by the parent company, and still larger ones, up to 3,750-kilowatts capacity, are under construction by Brown, Boveri et Cie., Baden, Switzerland. In a recent paper presented before the British Association, the Hon. Chas. A. Parsons states that in 1890, six years after the introduction of the multiple-expansion turbine, 360 equipments had been put into service, these equipments varying from 4 to 120 horse power in capacity, and aggregating 5,000 horse power. Up to the present time, 800 turbines have been sold, aggregating 200,000 horse power, the largest of these machines having a rated capacity of 3,000 horse power. The Swiss firm has sold since 1900 twenty equipments, the largest of 5,000 horse power. Summarizing: the aggregate sales of all builders of the multiple-expansion turbine, up to the present time, for purposes of electrical generation alone, approximate 300,000 horse power. In addition, the marine equipments noted elsewhere aggregate 82,900 horse power, thus making a grand total of 382,900 horse power, an increase of 640 per cent. per year of development within a period of 12 years since 1890.



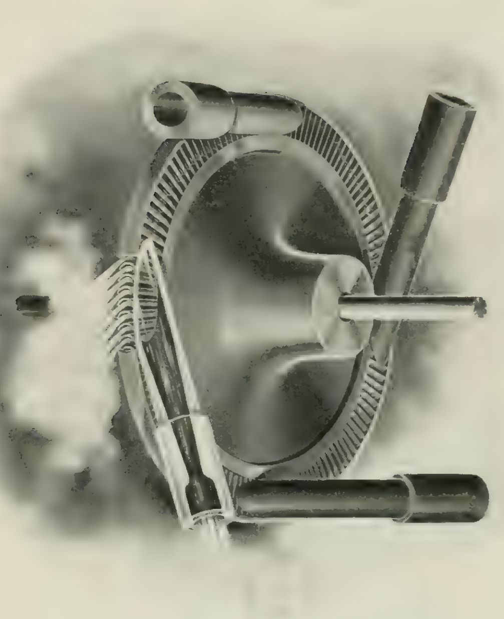
The tendency of modern steam-turbine development has been along three important lines—first, mechanical simplicity, second, steam economy, and third, speed reduction. Of the several types of turbine that have been proposed within recent years, only two have survived the test of application, the DeLaval, or impulse type, and the Westinghouse-Parsons, or multiple-expansion type. Others are employed in special instances on account of their compactness, and the excessive speed that is obtainable. The most important of these are the Dow, which is used for spinning the propeller of the Howell torpedo, and the original DeLaval, or reaction type, employed in dairy processes for operating centrifugal cream separators. The latter two types, however, are not important from the standpoint of power generation on a large scale, such as is now accomplished by the one type which has, by successful development, nearly monopolized this field, the multiple-expansion or parallel-flow type, represented in Europe by the Parsons, and in the United States by a modified and improved turbine—the Westinghouse.

In mechanical construction, the impulse turbine is perhaps the simplest, and employs the principle of the "hurdy gurdy" impulse wheel so common in hydraulic installations of high head. The construction of this turbine, although exact, does not involve such refinements as are characteristic of the multiple-expansion type. From a mechanical standpoint, the greatest functional shortcoming of the impulse turbine is the tremendous velocity of the bucket wheel and the necessary employment of gearing to transform the power derived from the impinging steam to a secondary or low-speed shaft. The design of the bucket wheel provides as far as possible against accidents from centrifugal rupture, but danger is always present from crystallization, or from hidden flaws in the material of the rim or of the flexible shaft. This point is more impressive when the actual rim speed is considered —500 to 900 miles per hour—a speed that is almost incomprehensible when compared to existing standards.



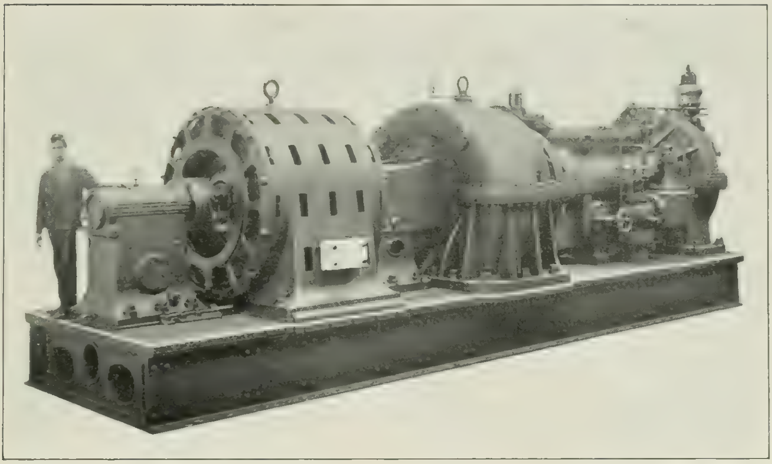
DE LAVAL 30-HORSE-POWER (20-KILOWATT) TURBINE DYNAMO.

This turbine is at present being manufactured in Europe and at Trenton, N. J., in sizes up to 300 horse power, and the latest designs with which the public are familiar follow closely the earlier designs in the arrangement of discs, steam jets, flexible shaft, helical gear, and throttle governor. It is a noteworthy fact that in point of size the gears and gear casing of this turbine occupy more space than the turbine itself. If these gears could be dispensed with, the DeLaval tur-



DE LAVAL TURBINE WHEEL AND NOZZLES.

bine would probably hold the record in point of relative size per unit of output. In the larger turbines, a double set of gears are employed, each driving a separate generator mounted upon an extension to the bed plate. The gears are designed and machined with great accuracy, this being necessary on account of their high speed, which ranges in the several sizes from 7,000 to 40,000 revolutions per minute. The nozzles are interchangeable and designed in such a manner that complete adiabatic expansion of steam takes place therein; the capacity of the machine may be varied between wide limits by the opening or closing of the several separate nozzles with which each machine is equipped. The bucket wheel is also machined with all possible care, its section being such that rupture from centrifugal force will be confined to the rim, into which are fitted the dove-tailed buckets, thus minimizing the extent of damage should rupture occur. The economy of the DeLaval turbine may be maintained at a high point under wide ranges of load by manual control of the nozzles, each of which, operating independently, secures the most efficient expansion of the steam. As the load increases, more nozzles may be put into operation, until the limit of capacity is reached, each step maintaining a high steam economy. This arrangement, however, debars the DeLaval turbine from service involving fluctuating loads. If these nozzles could be placed under the control of a suitable governor, this would largely increase the adaptability of this turbine to general service. In its present form, it is evidently restricted to a somewhat limited field of application. A large improvement in the efficiency of the impulse type may be looked for in the replacement of the throttling method of governing by some other more efficient method by



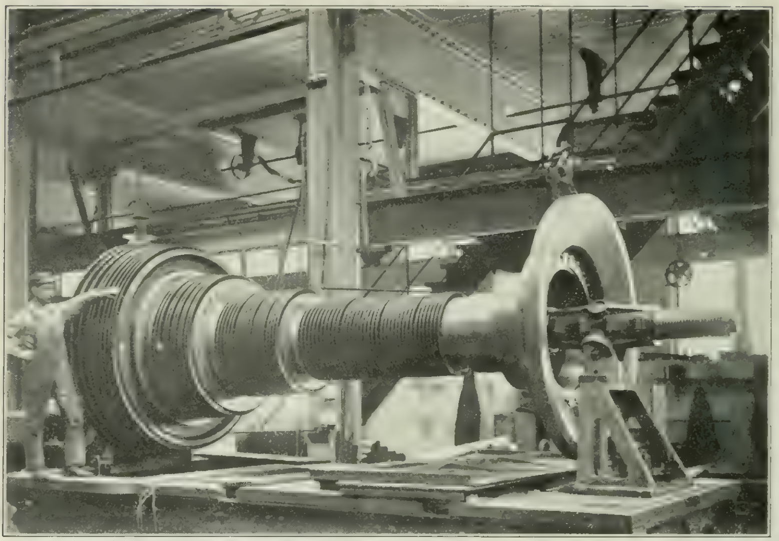
SHOP ASSEMBLY OF 1,500-KILOWATT WESTINGHOUSE TURBO-GENERATOR.

which the full boiler pressure may be utilized. In the present machines, the employment of the throttling governor results in a loss of from five to fifteen pounds of available steam pressure at loads corresponding to maximum economy with the number of nozzles in use. It is thus apparent that the endeavor to reach high thermal efficiency through high initial steam temperature is in a measure defeated by the use of this throttle governor.

Although handicapped by the necessity of speed reducing gear, and the absence of suitable automatic governing, the virtues of the impulse turbine are unmistakable, and it is enjoying extensive application to power work in small units from 1½ to 300 horse power.

The construction of the multiple-expansion turbine has also within the last few years been brought to a state of great simplicity, and difficulties which at first seemed well-nigh insurmountable have been overcome by alterations in the design, construction, and assembling of the component parts. This result has been attained mainly through the elimination of minor defects arising with the increase in physical dimensions, rather than through bold and radical changes in the turbine as a prime mover. The construction employed in the later machines necessitates machine work of the greatest accuracy and refinement, and the employment of the highest grade of materials obtainable, but the resultant turbine is a machine which after initial adjustment is nearly, if not entirely, invulnerable to those troubles which are unavoidable in the best reciprocating-engine practice.

An important feature of the multiple-expansion turbine which



ROTATING MEMBER OF 1,500-KILOWATT TURBO-GENERATOR.

contributes most of all to its constructive simplicity, is the fact that all of its main working parts are built and assembled upon a common center line. Recent Westinghouse construction differs materially from that of other types in the subdivision of the turbine into two parts. This change, however, is adopted in the larger sizes only, and affords opportunity for inserting a re-heater between the two parts, as well as for a considerable reduction of dimensions, which become unwieldy when the single-cylinder design is applied to the larger machines. The parting of the casing at the shaft line proves to be a valuable feature, as it permits access to the working parts by the raising of the cover, which exposes to view the entire spindle.

The problem of accurate balancing of rotating parts has been solved in each type with entire success. The flexible shaft employed by De Laval is familiar. In the Westinghouse works use is made of a specially designed balance which detects with remarkable nicety the slightest unbalancing, due not only to non-coincidence of geometric and gravity axes, but also to irregularities in the various parts of the revolving member which may not be corrected in the lathe, and which introduce, at high speeds, force moments tending to produce objectionable vibration. This balance is so sensitive that it can readily detect unbalancing amounting to only 0.002 per cent. of the weight of the part under test. The shaft is rigid throughout its length, and all vibration during running is completely absorbed by special oil-cushioned journals, consisting of loosely fitting concentric tubes, each being isolated or "floated" by a capillary oil film.

A distinctive characteristic of the multiple-expansion turbine is the method of governing employed. Instead of a steady blast of steam, throttled in proportion to the load, steam is admitted in short puffs, interrupted at regular intervals, and controlled by a sensitive governor of the fly-ball type. The duration of these puffs of steam is in direct proportion to the load on the turbine, each puff being admitted at boiler pressure and allowed to expand through the successive rows of turbine blades. The effect of this procedure upon the thermal efficiency is evident from the fact that thermal efficiency depends largely upon terminal temperature, as expressed in the equation $E = (T_1 - T_2) / T_1$, where E is the efficiency in per cent, $T_1$ the initial, and $T_2$ the terminal pressure, referred to the absolute thermometric scale.

From a commercial point of view, the steam turbine is important on account of its compactness as compared with reciprocating engines. The floor space occupied by a Westinghouse turbine of moderate size is roughly two-thirds that of a vertical, and two-fifths that of a horizontal Corliss engine of equal capacity. For a power-house equipment of 1,000 horse power, the total approximate engine-room cost, including real estate and buildings, is, for a turbine outfit, but 62 per cent. and 32 per cent. respectively of that of a corresponding equipment of vertical and horizontal Corliss engines. These figures are conservative, and a visual comparison of the two types of prime-movers only serves to accentuate them. The compactness of the turbine is largely due to the concentration of working parts into a single moving element, the absence of means for affecting a transformation of motion, necessary in a steam engine of the reciprocating type, and the employment of the simplest possible form of motion—rotation—for converting the energy of the working fluid into useful torque. The resultant motion fortunately happens to be suitable for direct power application in general, and especially so for the direct driving of alternating-current generators, a result accomplished with reciprocating engines only through the employment of large fly-wheel capacity, and heroic design of both engine and generators. Parallel working with the turbine becomes the simplest of operations, due to the entire absence of cyclical speed variations, which prove so troublesome and expensive in the case of the reciprocating engine. The speeds at which the later turbines operate further contribute to economy of gererator construction, by reducing the number of poles required for a given frequency. A few comparative figures illustrate this point:—The 5,000-kilowatt generators recently installed by the Manhattan Railway Co., N. Y., have 40 poles, an over-all diameter of 42 feet; and a speed of 75 revolutions, giving a frequency of 25 cycles per second; the 1,500-kilowatt turbo-generator unit at Hartford runs at a speed of 1,200 revolutions and a frequency of 60 cycles, necessitating 6 poles. Preserving the present construction, the Manhattan generator for 60 cycles would have a diameter of 100 feet, or twenty times that of the turbo-generator. The weight of the Hartford unit per rated horse power is 116 pounds, as compared with 400 pounds for the N. Y. Edison 6,500-horse-power units, and 500 pounds for the 4,500-horse-power units of the Boston Elevated Railway.

Concerning the point of speed reduction, much advancement has been made with the multiple-flow type through the simple expedient of increasing the ratio of expansion. The first Parsons turbine ran at 18,000 revolutions. In the modern machines of this type, speeds have been reduced to nearly 4 per cent. of this figure, thereby making possible the direct driving of generators and other apparatus without the interposition of speed-reducing gear. With the impulse type, practically no advancement has been made in speed reduction. The theoretical bucket speed, corresponding to maximum efficiency, is one half that of the steam issuing from the jet. This may, with a condenser, reach 4,000 feet per second, or 45 miles per minute, 50 per cent of which, 2,000 feet, is far beyond safe rim speed, thus introducing a further source of loss of economy which, though not prohibitive, is irremediable when only one expansion is attempted. The speed reduction of the multiple-expansion type is obtained by assembling turbine wheels in series ranging from 20 to 100 in number, according to conditions of vacuum and steam pressure, each wheel operating independently and contributing its proportion of the total torque to the shaft. The steam expansion in this type, in contradistinction to that of the jet type, is continuous from point of entry to point of exit. Each successive row of steam passages is so proportioned as to accommodate the increased volume of steam accompanying each successive step in the stage expansion. It is a point worthy of note that the extraordinary expansion secured in the multiple-expansion turbine is not accompanied by successive increase in either the size of the machine as a whole or in mechanical friction. With saturated steam, the usual extremes in temperature on the turbine casing range from 365° F. at the admission end, to about 126° F. at the exhaust end, this being accomplished, in the smaller sizes, within a distance of three or four feet. These temperatures correspond to a ratio of expansion of 1/64, which is ordinarily prohibitive in the reciprocating engine, and would involve an engine construction of such unwieldy nature that the losses from friction and initial condensation would many times exceed the benefit to be derived from stage expansion. As these losses are practically obviated in the turbine, it is evident that stage expansion may be profitably carried to the limit of condenser capacity, practically one pound absolute.

In point of steam economy, the multiple-expansion turbine at present excels, due to the greater range in terminal temperatures employed. The original Parsons turbine gave a steam economy of 35 pounds per electrical horse power, at 92 pounds pressure, equivalent to about 27½ pounds for indicated horse power at engine rating. A later turbine of Parsons, built in 1892, reduced this consumption to 27.6 pounds, and 20 pounds per electrical horse power were secured at 115 pounds steam pressure, with 60° F. superheat and 28 inches vacuum. In 1900, a 1,000-kilowatt turbine, built by Parsons for the Elberfeld corporation, showed an economy of 14.5 pounds per electrical horse power, with 130 pounds steam pressure, 27° superheat, and a high vacuum, which has since been slightly exceeded by large machines. The first American turbines tested were the 400-kilowatt units installed in 1899 at the Westinghouse Air Brake Works. They showed an economy of 16.4 pounds per electrical horse-power hour, with saturated steam at 125 pounds pressure and 26.5 inches vacuum. The second, and largest unit, installed at the Hartford Electric Light Co., shows a steam consumption at full load of 14.25 pounds per electrical horse power with steam at 150 pounds and 42° superheat. This consumption is equivalent to approximately 12 pounds per indicated horse power (85 per cent. total efficiency) at engine rating.

The economy of the impulse type of turbine has likewise undergone great improvement within recent years. The earliest machines of this class appeared in 1889. In 1892 a 50-horse-power machine running condensing, showed an economy of 26.5 pounds per electrical horse power. In 1896, a 10-horse-power turbine was tested at Sibley College, yielding an economy of 46.9 pounds per horse-power hour. A similar machine, tested later by Professor Goss, with four nozzles in action gave a maximum economy of 47.9 pounds per brake horse power, at 126 pounds steam pressure and 26 inches vacuum. A 150-horse-power turbine tested by Professor Cedarblom in 1897, consumed 19.6 pounds per electrical horse power, with 114 pounds steam pressure and 26.4 inches vacuum. The latest results upon the De-

Laval turbine are furnished by the American builders upon a 300-horse-power turbo-generator outfit recently tested at Trenton, N. J. This turbine was fitted with eight nozzles and used superheated steam at 200-pounds pressure; the economy at full load, with 64° F. superheat, with a vacuum of 27 inches, and all nozzles in action, was 15.4 pounds per electrical horse power. With saturated steam, the consumption at full load increased to 16.8 pounds per electrical horse power, and with only three nozzles in action this consumption rose to 20.2 pounds per electrical horse power. Although the high economy here obtained is in a measure due to the high steam pressure employed, these results are highly encouraging as indicating a close approximation to correct design.

An interesting investigation was carried out in 1897 by Prof. Jacobus, upon a 15-horse-power DeLaval turbine for the purpose of definitely ascertaining the effect of entrained moisture upon steam economy. The results indicated that the net consumption was the same for either dry or wet steam, and that to obtain the actual steam economy it was necessary only to correct observations for entrained moisture. This would appear to invalidate the theory of excessive fluid friction in the steam turbine when water of condensation is present. It is obvious that maximum thermal efficiencies are obtained only when adiabatic expansion is carried to the extreme. Although this may be readily secured in the turbine, the condensation at the end of the expansion might be considerable, entailing corresponding mechanical and thermal losses. If, however, the steam is superheated before admission, the point of condensation is deferred and the larger part of the working cycle is free from entrained moisture. Superheating is now used extensively in all turbine work, resulting in decided economies. It is likewise important to secure the highest possible vacuum, in turbine condensing systems, for the reason that the last expansion stages in the steam cycle are so easily provided for. At the present time, it is not unusual to exhaust at a pressure and temperature but little above that corresponding to the working vacuum. The following figures, derived from the Elberfeld tests by Messrs. Lindley, Schroeter, and Weber, indicate the economy of high vacuum and superheat. For each additional inch of vacuum an increase of 4 per cent. in economy was realized, and a superheat of 100° F., or 55° C., resulted in a similar gain of 12 per cent. These facts have evidently received serious consideration in modern turbine installations, many of which are operating with vacua of 27, 28, and even 29 inches, together with superheat temperatures ranging as high as 200° F.

A closing reference may be made to the Rateau turbine, lately introduced in France, and to the Curtis, a turbine now undergoing development in America but not yet placed upon the market. Both machines are designed upon the principle of the impulse type, compounded to a sufficient number of steps for the necessary speed reduction. The Rateau machines are manufactured in Paris and Switzerland, it is stated in sizes up to 1,200 horse power, but no official information appears available further than general details of construction. The Rateau machine is built in two stages, somewhat similar to the multiple-expansion type. The rotating part consists of a single shaft supported by two outer bearings and one inner, upon which are mounted twenty-five impulse wheels, fifteen in the first stage and ten in the second. These wheels have dished sheet-steel centers, and radial buckets riveted to a peripheral flange. Between each pair of rotating discs is mounted a stationary disc or diaphragm, containing around its periphery four groups of guide blades. These diaphragms fit accurately the interior of the casing, but surround the shaft with a loose fit. Steam enters the turbine through four segmental groups of guides corresponding to four jets in the impulse type. The subsequent increase in volume is provided for by gradual increase in area of the four peripheral jets containing the guide blades. The turbine is especially designed for marine service, as no provision has been made for axial thrust other than that furnished by reactionary propeller thrust.

The Curtis turbine resembles in some respects the Rateau in the employment of a series of impulse wheels for obtaining speeds suitable for general power work. The machine possesses many valuable features but is practically unknown at the present time. Its probable appearance in the near future will, however, serve to stimulate further the interest of steam users, already aroused to the possibilities of the turbine by the performance of those now in use.

From the foregoing, it is apparent that within a period of less than two decades the steam turbine has reached a state of mechanical excellence and economy equal to, if not greater than, the best types of stage-expansion engines in existence. The steam engine has. through nearly two centuries of continued improvement, reached the zenith of its career of usefulness, and is in danger of replacement by either one or both of its two thermo-dynamic superiors, the steam turbine and the gas engine. The present field of usefulness for the turbine is broad, and the advancement which has already been made towards its ultimate perfection presages the most excellent results for the future.

# EDITORIAL COMMENT

THE advance of civilization has been marked—almost measured—by the progressive withdrawal of Government direction of private and business affairs. This is not the philosophy of Socialism, but it is the reading of fact. Whether one regards greater individual enlightenment as the natural outgrowth of greater personal and public liberty, or considers the greater freedom a condition permitted by wider-spread and higher average intelligence, depends upon his school of thought; but whatever his interpretation of the evidence, he will see that, viewed in the large, it shows the distinguishing feature of political advance to be the continual shrinking of the functions of government within an ever-contracting field, and the complementary enlargement of the province within which the social or industrial unit is freed from physical restraint.

It is deplorable, therefore, when a step backward is needed—when police powers must be reasserted and used upon some individual who has not the sense or the morals to be allowed freedom in the direction of his own affairs. Such a spectacle, unfortunately, has just been offered in the necessary intervention of the municipal and State powers to compel some sort of decency in the conduct of the local railways of New York City. It is the more humiliating because in this very field we have lately been offering to set others' houses in order—because in all that goes to the mechanical handling of huge railway problems we have made reasonable claim to be able to teach the world. The traffic conditions are admittedly difficult in New York, but no one could maintain for a moment that the transportation companies—especially the Manhattan Railway and the Brooklyn Rapid Transit—have done half what ordinary intelligence would find possible in solving the problems presented. How poor was the service is well shown by the fact that a public commission, after a very brief examination, could formulate relief measures which, whatever may be thought of their entire sufficiency, are admittedly wholly practicable.

For the surface lines there is much excuse in the ill-regulated, or rather chaotically unregulated, street traffic; but it would be an insult to the intelligence of the management of the elevated railways to assume that the brutalities of the present service could not be greatly relieved if the rights of the public, rather than the collection of the largest possible number of nickels at the smallest possible expense, were made the first consideration. As it was, however, the policy of "the public be damned" has been allowed to direct until a too-long suffering community has undertaken to deal with this archaic institution as its semicivilized state demands, and curtail the freedom to direct its affairs which it has proved its unfitness to exercise.

* * *

THE coal famine is bringing home, as perhaps nothing else could, another point in which the public welfare has been of no consideration to those who were seeking private advantage. The settlement of labor disputes by strike, at any cost to the helpless third party—

the public—has been of scarcely more than academic interest to that third party because the invasion of its interests has generally been too remote or too local to be generally appreciated. But to touch the coal pile is to touch the heart of modern life, and the whole country is keenly interested in the public inquiry into the conditions which made last summer's deadlock, and this winter's consequent suffering, a twentieth century possibility. So far, the showing has been little creditable to either side. But sunlight goes a long way toward curing disease, and the mere bald uncovering of the evils which have been hidden in this fundamental industry may do much toward bettering labor relations throughout the country.

* * *

One of the most interesting things which has appeared of late in the domain of electrochemistry is the fact that it has been found advisable to form a commercial organization for the express purpose of conducting a continuous campaign of scientific research.

Thus there has been organized at Niagara Falls a company whose object is not to manufacture anything in particular, but to conduct experimental researches upon a large scale with a view of developing methods and processes in electrochemistry for disposal to operating companies or other purchasers. When it is understood that the control of this organization is in the hands of such well known scientists as Professor F. B. Crocker, Mr. C. A. Doremus, Mr. S. S. Wheeler, and others, it will be understood that it is no speculative matter, but a serious and well equipped attack upon such problems as offer any reasonable prospect of successful solution.

Already the work of members of the company has developed such results as the method of producing artificial corundum by the fusion of bauxite, and also the process of fixation of atmospheric nitrogen and the production of nitric acid and artificial nitrates, both of which processes are in commercial operation by undertakers to whom they have been disposed. Other investigations are constantly being carried out, and with the command of electrical energy available at Niagara Falls, there is every reason to believe that many valuable developments in the field of synthetic electrochemistry will result.

Apart from the special interest which must be felt in such a combination of science and business, this undertaking attracts attention as showing the difference between modern methods and those of the old-time inventor. Invention, the finding out of things, formerly was supposed to belong to certain individuals possessed of the divine spark, much in the same manner as a musician is supposed to develop and record the inspirations which he receives. Now, however, systematic attacks are made upon natural forces, and all the resources of the physical, chemical, and mechanical laboratories are brought to bear upon their secrets. In this respect the engineer is simply doing what the chemist has done long before. The period of empirical trials and experimentation of the alchemists has been replaced by the orderly and systematic investigation of the analytical laboratory, and it is altogether in the order of progress that the mechanical and electrical laboratory should join in this rational and effective method of development. The interesting thing about this present undertaking lies in the fact that it is a cold business proposition, and thus adds another to the series of instances of the appreciation of the commercial value of theoretical scientific research.

* * *

We are reminded again of the shortcomings of the daily press in reporting technical matters by an elaborately intricate bull, gravely put forth recently by a newspaper which has always been noted for self-satisfaction that it is not as other papers are, unreliable, untrue, but rather an absolute guarantor of accuracy. The freak item in this case was a special dispatch giving a minute history of an accident by which a student had been shocked to death as he sat in his room, his feet resting on the radiator and his hand clasping an electric lamp. An "electrical expert" who was called in found "a current of 572 volts," which showed that "just twice that number, or 1144 volts, were loose somewhere about the place." The mystic number "suggested the explanation." There was a high-tension current of 1040 volts entering the building, which was stepped down to 104 volts for the lighting service. By the aid of a "fallen guy wire" and passage through "200 feet of frozen ground," the two currents had both got on to the same wire, and there you are—1040 + 104 = 1144. The "eleven-forty-four" are accounted for, but what has happened to the "four" which usually forms the first member of the famous "gig"?

To err is human, and even Jove nods. But it certainly seems unnecessary to go out of the way to invent and elaborately embroider stories so grotesque as this.

* * *

The plan of the United States Steel Corporation to include its employees among its stockholders, according to the scheme widely announced in the newspapers, has successfully passed its first stage by the general acceptance of the method by the men. The total amount of stock allotted by the finance committee has been over-subscribed, there has been no serious opposition by labor organizations, and the whole affair is launched. With such an excellent start there is every reason to believe that the ultimate purpose of the Corporation in undertaking the scheme will be to a great extent accomplished. This purpose, as contained in the announcement circular, is, in brief: to associate the employees in the work of more closely organizing and systematizing the business of the Corporation as a harmonious whole; to interest the men in the reduction of general expense; to offer to the men an inducement to remain permanently in the service of the Corporation; and to avoid the defects in those profit-sharing plans which depend upon the working of local portions of a plant for their operation.

The extent to which these objects are accomplished will be watched with interested attention. At the recent meeting of the American Society of Mechanical Engineers one of the members stated that a certain preventive of labor troubles was to give the workmen an interest in the business. Those who do not want labor troubles prevented, professional agitators and the like, will see in the plan a deep-laid scheme to undermine their efforts, but so far any under-current of opposition has been either stemmed or suppressed. Some will doubtless class the scheme with so-called "gift" methods of remunerating labor, but others will see in it but a method of determining what the real value of labor is, and as such commend it as a stride in the right direction.

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By an error of transcription, the Gould storage battery and booster shown on pages 573 and 574 of our January number were described as installed in the "Commercial Cable Building." It should have read "Commercial Building." The Commercial Cable Building has a Chloride Accumulator installation put in by the Electric Storage Battery Co.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

# LIMITATIONS IN HEAVY ELECTRICAL ENGINEERING.

## SOURCES OF POWER FOR THE GENERATION OF ELECTRICITY AND PRACTICAL METHODS OF APPLICATION.

*James Swinburne—Institution of Electrical Engineers.*

MR. SWINBURNE is always entertaining, even if he is not always strictly accurate, and his presidential address before the Institution of Electrical Engineers shows him at his best in both respects.

Readers of *Punch* in days gone by may remember a clever cartoon in which Mr. Gladstone and Lord Beaconsfield are represented as standing at a book stall, each with a book in his hand; Gladstone dipping into Lothair with a contemptuous look on his face, and Beaconsfield looking at Juventus Mundi. Says Gladstone: "Ha, flippant!" while Beaconsfield, with a look of disgust, replies: "Hum, prosy!" So it is with presidential addresses. Too often one cannot but echo the refrain: "Hum, prosy!" and so we must not yield to the temptation which at first besets one in reading Mr. Swinburne to exclaim: "Ha, flippant!" For there is much good stuff in Mr. Swinburne's address even if it departs somewhat from the portentous solemnity which is usually considered necessary upon such momentous occasions, and although dreams of the future must be expected to be more or less fantastic, like all dreams, yet this one is at least founded upon fact.

The main fact with which Mr. Swinburne concerns himself, after some pleasantries upon the relation of applied science to practice, and the especial mission of the electrical engineer to set all his older engineering brethren right, is the nature and extent of the limitations of heavy electrical engineering. At least that is what the title indicates to be the subject, although the matter itself relates far more to the general subject of power generation than to its subsequent transmission and application by means of electricity. Like very many electrical engineers, Mr. Swinburne, having extended the scope of his work to the broad domain of mechanical engineering, calmly assumes that it is all henceforth electrical, and proceeds to treat it as such.

Starting with the development of power from falling water, he dismisses the energy of the tides as unprofitable, mainly because of the great capital expenditure necessary to obtain a continuous power of any magnitude, and proceeds to examine the utilisation of waterfalls in general. There is no doubt that there has been much foolish talk about the advantages of water power, especially as regards its low cost, but it is now fairly well understood that the interest upon the first cost, together with establishment and depreciation charges, form a very material element in the cost of hydraulic power, but that in spite of these facts new water powers are being developed continually in those parts of the world so fortunate as to be possessed of suitable sources. It is indeed true that water power is not generally where it is wanted for existing industries, but experience in various parts of the world has shown that one of the notable effects of the development of water power has been the creation of new industries, notably in the domain of electro-chemistry, and that these new industries have not the slightest objection to establishing themselves even in somewhat out-of-the-way localities. The statement that a water power, to be really valuable should be on the sea, will be interesting news to the great companies at Niagara, at Rheinfelden, at Foyers, or at the Sault-Sainte-Marie. The idea that it is only the landlord who is benefitted, hardly agrees with the facts as to the inducements which power companies offer to prospective power users in connection with building sites, but possibly all our ideas upon these subjects are in need of revision. So far as the electrolytic production of alkalies is concerned, their development at water-power sites is a matter of record, and in the United States, at least, it is well known that one of the greatest manufacturing companies concerned with the production of alkalies is quietly occupied in the development of available sources of water power, to hold as a reserve in case the newer process should become of sufficient competitive importance.

The production of electricity directly from carbon is shown by Mr. Swinburne to be in contradiction to the modern theory, since carbon never forms ions, has therefore no solution pressure, and can therefore give no electromotive force.

Concerning the steam engine as a means of developing motive power from heat, Mr. Swinburne shows that any possible improvement in efficiency depends upon the extension of the heat range, and is of the opinion that this is more probably to be extended at the lower end than at the upper. The advantages of superheating are shown to be due mainly to the reduction in cylinder condensation and not to the getting of more energy into the steam, a point which is very well appreciated in steam engineering circles already, but it is precisely in this matter of cylinder condensation that the greatest gains in economy are possible. As for greater range of temperature, that is certainly to be found in the use of the internal combustion engine, and not in the steam engine. The small gain to be expected from any form of binary vapour engine does not appear to warrant the additional complication involved.

Having set the engineering world right with regard to water-power, steam, and gas engines, Mr. Swinburne proceeded to explain that he differed with Clausius, Zeuner, and Macfarlane Gray concerning the nature of entropy, and that he considered 90 per cent. of the text books to be in error on the subject. The orthodox conception of entropy may safely be left in the hands of its friends for defence, and already Professor Perry has joined issue with Mr. Swinburne on the subject, so that point need not be further discussed here. Mr. Swinburne also appears to have just discovered the Diesel motor, and kindly offered to defend it against any prejudices which might appear against it in England because of its extreme novelty, notwithstanding the fact that it has been before the engineering world for more than five years.

Finally coming to electrical matters, Mr. Swinburne discusses dynamos, transformers, cables, batteries, and lighting problems in a most interesting and forcible manner. Dynamos and transformers he considers to have nearly reached their limit of improvement, the efficiency of generators already being so high that any further reduction in losses would make no appreciable difference in the total efficiency of a station.

In the field of accumulators, however, there is undoubted room for improvement. Even with its present defects it is of great value for equalising purposes in central-station work, and further improvements may be expected to produce very great changes in important branches of engineering. At the same time he seems to be convinced that we are limited almost absolutely to lead and sulphuric acid as materials for accumulator construction. The requirements are extensive. We want lightness, large capacity, cheapness, rapid discharge, efficiency, mechanical strength and durability, and many of these requirements are antagonistic. Large capacity means rapid deterioriation, while mechanical strength means weight. It is almost impossible to make intelligent comparisons between published reports of battery performance because essential facts are omitted.

Concerning the nickel-iron battery, with alkaline electrolye, Mr. Swinburne is unable to speak at length, owing to the limited amount of reliable information available.

There is material room for improvement in cable insulation, and notwithstanding the great importance of the subject, there is no branch of electrical industry which is run on less scientific lines. At the present time the whole art of cable making is a question of trial and error, with the latter element predominating. Even the matter of cable testing is subject to no definite rules, and hence little systematic information is available.

Condensers are dismissed as being hardly worthy of discussion in view of the small demand for their use, but the subject of light is taken up at length. Naturally the whole trend of this portion of the address is toward a higher degree of efficiency in the conversion of energy into illumination. The cold light of the glow worm and the fire-fly appears to be as far away as ever, although there is no thermo-dynamical reason why electrical energy should not be converted directly into radiation of any wave length without loss. Apparently the limits are altogether practical—the thing may be done, but we have not yet hit on the way of doing it. The Cooper-Hewitt mercury vapour lamp is apparently in the line of progress, but the colour of the light is objectionable.

The arc light is also open to improvement, mainly in the direction of the utilisation of the large portion of light now lost in the crater. In addition to this the electrical power in the space directly between the electrodes should also be converted directly into light, and added to the radiation from the incandescent carbons.

Mr. Swinburne discussed also the future possibilities of electric traction, together with the vexed problem of the electrolytic corrosion of buried pipes by stray currents, and thus closed a most interesting and stimulating address.

## THE ELECTROLYTIC ALKALI INDUSTRY.

### ITS PRESENT POSITION IN VARIOUS COUNTRIES IN CONNECTION WITH THE UTILISATION OF HYDRAULIC POWER.

*John B. C. Kershaw—The Electrician.*

IN a series of papers reviewing the present position of the electrolytic alkali industry, published in recent issues of the *Electrician,* Mr. John B. C. Kershaw shows the relations of the electrical process to the earler methods, and discusses the relation of market conditions to the development of the industry. Since the greater portion of the electrolytically produced alkalies is the result of the utilisation of hydraulic energy, this review forms also an indication of the extent to which water power enters into the question of competition.

In Great Britain hydraulic power does not appear in the question, but the cost of fuel does, and it is a significant fact that the Castner-Kellner Company has decided to introduce Mond gas for firing at their works at Weston Point, in order to offset the increased cost of solid fuel. The total amount of power used at Middlewich and Weston Point is now 7,000 horse power, corresponding to a production of about 25,000 tons of bleaching powder per year by the electrolytic process.

The industry appears to be making fairly satisfactory progress in Germany, both by the use of steam and hydraulic power. At Bitterfeld a steam plant of 4,400 horse power, is in operation, using brown coal for fuel, and producing by electrolytic processes 7,200 tons of caustic potash and 12,250 tons of bleaching powder per year. A branch of the same company at Rheinfelden is utilising 3,400 hydraulic horse power, producing 5,800 tons of caustic potash and 10,000 tons of bleaching powder, besides a quantity of calcium carbide. In connection with the output of the works at Griesheim the total output of electrolytic alkalies amounts to 25,000 tons of caustic potash and 40,000 tons of bleaching powder per year, this exceeding the home consumption to such an extent that the exports are more than 25,000 tons.

In France electrolytic methods are used in a number of establishments. Thus the Société des Soudières Electrolytiques is using 2,600 hydraulic horse power for the production of sodium and sodium peroxide at Les Clavaux Isère. The St. Gobain Chemical Co., the Societe des Fives-Lille, and the Compagnie Générale d'Electrochemie are operating plants of moderate size, while others are in course of construction. The development of the alkali industry in France is undoubtedly dependent upon the course of market conditions, and for the present, at least the greater portion of bleaching powder there will continue to be produced by the old Le Blanc process. Of the total of 30,000 tons manufactured in 1900, more than one-third was for export, showing that the development of the industry is dependent upon the development of export trade.

Switzerland has at present only two works in active operation, one being the Société Suisse de l'Industrie Electrochimique Volta at Chevres, near Geneva, with an annual output of 600 tons of caustic soda and 1,440 tons of bleaching powder; and the other the Société des Usines de Produits Chimiques des Monthey en Valais, equipped with 1,500 hydraulic horse power, and producing annually 1,000 tons of caustic soda and 2,500 tons of bleaching powder. In view of the uncertain state of the market at the present time both of these establishments are devoting a portion of their power to the manufacture of pharmaceutical products.

In other parts of Europe electrochemical works are in operation, and Mr. Kershaw notes establishments in Belgium, Russia, Austria, Italy and Spain. These are mainly operated by steam power, and in Belgium and in Russia the works are under the control of the Solvay company.

"Summarising the details given above as regards the power available and in actual use in Europe for the production of alkalies and bleaching powder by electrolytic methods, it appears that about 40,000 H. P. is available, and that only about 28,000 H. P., or rather more than two-thirds of this power, is at present being utilised in the industry. The recent fall in the selling price of bleaching powder will probably, still further reduce this total, for the owners of the electrolytic alkali works are likely to devote an increasing proportion of their power to the production of fine chemicals and by-products, which offer a large profit to the makers.

"The position of the electrolytic alkali industry is, perhaps, on the whole more promising in the outlying countries of Europe, which up to the present time have depended altogether upon the United Kingdom, Germany and France for their supplies of the heavy chemicals—soda and bleaching powder. In Russia, Italy, Spain and Austria some development and expansion of the industry may therefore, be expected, and in time the home demand of these countries will, probably, be entirely supplied by the locally-situated works.

"In the United Kingdom, Germany, France and Switzerland the position is less favourable, for the home demand is already more than covered by the production, and a considerable proportion of the output is exported. With the growth and development of electrolytic processes in other countries this export trade in heavy chemicals is likely to decline in volume and value, and the further expansion of the electrolytic alkali industry in two of the four countries named can only take place by the decay and decline of the older Le Blanc process, which still supplies in the United Kingdom and in France more than three-fourths of the total production of bleaching powder."

Coming to the United States, it appears that the Castner Electrolytic Alkali Company, at Niagara Falls, is the largest producer of alkali and bleach in America. This company is at present using 6,000 hydraulic horse power, and producing 36 tons of caustic soda and 90 tons of bleaching powder per day. The Ackers Process Company, also at Niagara Falls, is producing alkali and bleach by the electrolysis of salt. This method is based upon the electrolysis of fused salt with molten lead as cathode. At the present time more than 3,000 horse power is used, with a production of about 12 tons of caustic soda and 26 tons of bleaching powder per day, and the works are being enlarged. The process is noteworthy for its efficiency, the product and current consumption showing a current efficiency of 92 per cent., and an energy efficiency of 55 per cent.

The American Alkali Company, at the Sault Sainte Marie, uses 1,000 horse power, and has a capacity of about 3,000 tons per year, and there are other smaller establishments. Mr. Kershaw makes some analysis of costs with such data as are at his disposal, and shows that the total cost of 1 ton of 72 per cent. caustic soda, and 2.1 tons of 35 per cent. bleaching powder by the best of the electrolytic processes will be about £14. The present selling value of the above amounts is about £22, and the value when the drop in the value of bleach will become effective is £17.5s. Even under the present and immediate future conditions, therefore, business prospects are not unfavorable.

# THE REMOVAL OF OCEAN BARS.

UTILIZATION OF THE REACTIVE EFFECT OF CURRENTS FOR THE DEEPENING AND MAINTENANCE OF CHANNELS.

*Prof. L. M. Haupt—American Association for the Advancement of Science.*

THE question of the improvement of harbors by the deepening of channels is a matter of pressing importance. Already the great cargo steamers have reached a draught closely approaching the limit of depth of the most important ports of the world, and in some instances the tides have to be closely watched before vessels of more than 30 feet draught can venture over the bars of such harbors as New York and other great ports. When it is realized that still larger vessels are under consideration and that the great economy of large cargo carriers indicates the possibility of a demand for vessels of 1,000 feet in length and at least 40 feet draught, it will be seen that deeper channels must be obtained in response to the demands of commerce.

Under these circumstances the paper presented before the meeting of the American Association for the Advancement of Science, at Washington, by Professor Lewis M. Haupt, treating of the utilization of reaction in the removal of ocean bars, is of present interest.

At the present time the principal methods for deepening the channels through ocean bars are by dredging, by the use of dynamite, and by the construction of twin jetties. Usually the method relied upon is a combination of jetties and dredging, the latter being found necessary to assist in maintaining the channel produced by the former.

Where there is a sufficient discharge, as at the mouth of a great river like the Mississippi, two parallel jetties give good results, although even there some dredging has been found necessary. In like manner parallel jetties have been most successfully used at the mouth of the Panuca river, Tampico, Mexico, but this method involves the existence of a river discharge from above, and of a littoral current of sufficient strength to remove the sediment carried out beyond the jetties, otherwise a new bar is apt to form.

In late years, however, there has been appeared a disposition to study and imitate the methods of Nature in the control of hydraulic channels, especially in river regulation, and this method has been developed so far as it is applicable to harbor improvement by Professor Haupt in the design of the so-called reaction breakwater.

A study of natural deep channels shows that they are not formed between parallel banks, but almost invariably occur on the concave side of curved banks. Furthermore, the greatest depths are not necessarily in the path of the greatest current velocity, but appear where the scour of eddies bores into the sand or mud. Unless aided by artificial guidance, however, the depths produced by the action of the movements of the water itself, are rarely in the locations required by commerce, and hence some structure arranged so as to augment and guide the natural action of the existing forces becomes necessary.

The abnormal depths sometimes met in portions of channels are caused, in Professor Haupt's opinion, by eddies operating in a vertical plane, these eddies being caused by obstacles placed in the path of the current in such a manner as to retard the flow by the interference due to converging forces. The result is the production of a head producing downward scour, until compensation is secured by enlarged aperture. Such an action is necessarily supplemented by an upward resultant, accompanied by deposit, a bar being the sequence of a pocket, unless other forces come into action.

By producing eddies in a horizontal plane the effects of scour can be produced in any desired location by the construction of a single curved breakwater of proper shape and position. This method which has been advocated by Professor Haupt for a number of years, has been tried in several cases, and found effective in training the natural forces in the water to do the work without assistance from dredging.

In this method it is seen that physical agencies become of fundamental importance, and hence they must be carefully studied in each instance and the work adapted to the location under consideration. Bars formed from littoral drift must be clearly distinguished from those due to the detritus carried down by streams. For tidal inlets it is also important to ascertain the prevailing direction of the littoral movements. These have frequently, but erroneously been supposed to follow the prevailing winds, whereas they are more frequently found to be the resultant of the configuration of the adjacent coast line and of the angular wave movements, especially during the flood tide, when the waves are most heavily charged with silt.

For tidal inlets it is necessary to provide free admission of the flood tide, this being the only available source of ebb energy, together with protection of the bar channel from the prevailing direction of littoral drift. By then conserving the energy of the ebb tide, as it passes seaward, its action may be concentrated upon the bar crest. This result may be accomplished by the construction of a single curved breakwater, placed in the way of the ebb current in such a position as to maintain a continuous reaction along its concave face.

In order to protect the proposed channel from littoral drift, the jetty should not be submerged, but should rise above the highest tide. It should also be placed between the channel and the source of the prevailing drift, just as a snow or sand fence must be placed to windward to protect a line of railway. It should be curved concave to the effluent currents, in order to develope a continuous reaction, and should be constructed inwards from the outer slope of the bar, to avoid the advance of the crest and to utilize the force of gravity in cutting downwards, instead of upwards.

Professor Haupt discusses at some length the conditions existing in New York harbor, as well as at other points, and refers to the success which has attended the action of a breakwater constructed according to his plans at Aransas Pass, Texas. The extent to which natural forces may thus be directed to produce and maintain deep channels appears to be limited only by the nature and force of the currents, and in nearly every case it appears that a single curved jetty, properly shaped and placed will do the work better than a pair of parallel ones, especially in the case of pure tidal action.

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# MODERN REFUSE DESTRUCTORS.

### COMPLETE COMBUSTION AT HIGH TEMPERATURES ESSENTIAL TO SUCCESSFUL OPERATION—STEAM GENERATION A SECONDARY CONSIDERATION.

*W. Francis Goodrich.*

EVER since the stir which was made by the successful operation of an electrical generating plant from the waste heat of refuse destructors at Shoreditch, the question of getting steam power has been a prominent element in destructor design. This is only natural, since the disposal of refuse has generally been an important element of municipal expense, and any prospect of meeting at least a portion of that expense was welcomed. At the same time it is possible to carry the utilisation theory too far, and to lose sight of the main question at issue, the complete and satisfactory conversion of refuse into inoffensive inorganic matter. In a paper recently presented before the Manchester Local Section of the Institution of Electrical Engineers, Mr. W. Francis Goodrich, states the case for the modern destructor in a very intelligent and instructive manner, and some abstract of his views is here given.

In the first place it must always be borne in mind that high temperatures are absolutely necessary for the satisfactory combustion of refuse. This is especially important when the generation of steam forms a portion of the operation. The combustion chamber should be maintained at a temperature of at least 2,000°F., and higher if possible, and never, even for a brief period be permitted to fall below 1,600°F. Continuity of high temperature is the essential, not only for complete combustion, but also for steady steaming, and this feature should be kept constantly before the designer.

It will at once be realised that this condition is not compatible with close proximity of the boiler to the burning refuse, since the temperature of the water surfaces will always be below 400°F. Even when the boiler is placed well beyond the combustion chamber, and the latter is made of ample size, care must be taken that the furnaces are not cooled. Thus, when cells are erected in pairs, with the boiler between them, so that one out of the two shall be in full work while the other is being charged and clinkered, it often occurs that the heat which should be assisting the cell which is being clinkered is abstracted by the boiler, and imperfect combustion is the result. Under such an arrangement there may be a cell in full work on one side of the boiler, while on the other there is a comparatively cool cell, which after being charged must at first distil a large volume of green gases. These should obviously be caused to intermingle with gases at a high temperature to insure complete cremation, instead of which they come into immediate contact with the comparatively cool boiler surfaces.

The best arrangement is that in which a high temperature is maintained at all times in each cell, the combustion chamber being always fed with hot gases and providing a place for the final completion of the combustion in addition to the work actually done in the cells themselves. Thus in one type of destructor there is a continuous grate 20 feet long by 5 feet wide provided with four ashpits, and four charging doors arranged along the side, one-fourth of the cell can be clinkered and charged at a time, and three-fourths is always at work. This insures a high temperature in the combustion chamber, besides compelling the green gases from all except the last section to pass over the incandescent beds of one or more of the active sections.

Another feature which should be observed to aid in the maintenance of high furnace temperatures is the provision for charging the refuse in small quantities at frequent intervals. The difference between feeding refuse in small quantities into a hot and active cell and the dumping of a heavy charge into a cool and idle cell needs only to be mentioned to be appreciated.

As an additional element in the maintenance of a high temperature the use of heated air should be considered. By the use of a regenerative system, in which the incoming air is heated by the discharge gases, a most beneficial effect may be produced in promoting rapid ignition of the charge and an easy continuity of high temperature. This is especially important when there is much moisture in the refuse, either as a matter of local conditions or because of rainy weather.

The question of charging is discussed by Mr. Goodrich in an interesting manner. There is no doubt that it is desirable to have the refuse, always more or less offensive, delivered into the destructor cells with as little delay as possible, but when it is dumped in at the top in quantities of one to two tons at a time the combustion must necessarily be checked. At the same time the feeding of small quantities at a time by hand through ordinary firing doors admits cold air and tends to retard combustion to some extent, although this is the method preferred by Mr. Goodrich. A satisfactory method of continuous mechanical firing, which will handle the varied forms of refuse which come to a destructor, still remains to be devised, although it seems as if some modification of the travelling chain grate might be found to answer. The question of increased cost of mechanical firing, alluded to by Mr. Goodrich, is a serious one, and it undoubtedly is necessary that a satisfactory form of mechanical feeding device should also enable some labour-cost to be reduced.

It will be observed that in all this discussion nothing has been said as to the power-generating end of the plant, but this should always be given the second place, the prime object being the disposal of the refuse.

"It has been said that thorough cremation and really efficient power production are not compatible, and that they cannot take place coincidently; extremists have told us that if due attention is given to the primary purpose of the destructor, it will be of little service for power production. Seriously as this has been urged, to the detriment of useful combination, it is an argument which will not stand. It is true that if the steam boiler were placed in the very best position for heat absorption the destructor would be inefficient as a destructor, but it is equally true that the destructor, which is most satisfactory as a destructor, is the one which is so designed that the products of combustion are subjected to immediate high temperature contact, and of sufficient duration to secure their perfect cremation. In this process a large volume of high-temperature gases is produced which passes to the boiler, and that continuity of high temperature, which is of the utmost value from a sanitary standpoint, is at the same time the justification of the destructor as a power producer."

An important feature in connection with the combination of destructors and generating stations is the complete separation of the electrical portion of the plant from the destructor. Even with the utmost care there will be a considerable production of dust which is of a very penetrating character, and hence the destructor should be separated from the power house by a high and thick wall, and every precaution taken to prevent the dust from causing trouble with the electrical machinery. The entire works should be under the supreme control of a competent engineer, who should have charge of the electrical plant, and command the operatives of the destructor plant, division of authority being a serious impediment to satisfactory results.

A serious difficulty to the success of a combined destructor and electric plant lies in the fact that the current is in most cases used mainly for lighting, so that the power is all required during the comparatively short portion of the day. If the plant could be maintained in continuous operation for 24 hours a day, much better results, both as to efficiency and completeness of destruction could be obtained than when operated for but a short period at a time.

If power supply and tramway service can be added to the lighting, so that the load may be fairly well distributed, such an arrangement is much to be desired, otherwise the plant must be much larger, in order to deal with the entire day's refuse in a small portion of the time.

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# THE STRENGTH OF RAILS.

## EFFECTS OF SEGREGATION UPON THE STRUCTURE AND STRENGTH OF STEEL RAILS—CAUSES AND REMEDIES.

*Mr. Thomas Andrews—Society of Engineers.*

THE increasing importance of strength and soundness in rails and the very serious consequences which may follow unforeseen defects, renders the paper upon segregation, recently presented before the Society of Engineers by Mr. Thomas Andrews one demanding serious consideration. The chemical tests may show the material to be in compliance with specification requirements, and tests of certain specimens may give satisfactory results, and at the same time the segregation of the combined carbon and other elements may introduce local weaknesses of a serious character. The paper of Mr. Andrews discusses the existence of such conditions, and endeavors to show their causes and possible remedies.

The investigations of Mr. Andrews revealed the existence of segregation at various points in the transverse section of rails, especially at the junction of the head with the web. Such segregation is productive of uneven physical structure, and also of initial internal stresses liable to promote fracture under concussion or vibratory stress. Thus the tabulation of a number of investigations showed that as between the top of the rail head and the central area of segregation near the centre of the rail head, the carbon had segregated to about 59 per cent., the silicon to the extent of 47 per cent., the manganese to the extent of 8 per cent., the sulphur as much as 60 per cent., and the phosphorus to 46 per cent.

In other instances still greater differences in local constitution appeared. Thus, in another group of analyses of drillings, the most congested and concentrated portion of the segregation was found to be situated at the junction of the rail head with the web, in the central portion of which the combined carbon was found as high as 0.70 per cent. This showed that a maximum segregation to the extent of more than 133 per cent. existed in this part of the rail compared with the combined carbon found near the outer and other portions of the top and bottom part of the rail. The situation of this nucleus of segregation, at the junction of the head with the web, a place where great strength should be found, indicates the serious action of segregation in promoting variable physical properties, resulting in a material reduction of the resisting strength of segregated steel rails.

In order to show more effectively the nature of the effects of segregation upon the structure of the material, the methods of metallography were utilised, portions of the metal being polished, etched, and examined under the microscope. Photographic reproductions of one of the effects thus obtained accompany the paper of Mr. Andrews showing very clearly the difference between the normal micro-structure at that of the segregated portions. In the latter examples not only is the segregated structure indicated in general, but details of the constitution are clearly shown.

Thus it is clearly seen that the segregated condition of the combined carbon and the micro-segregation of the sulphide of manganese and iron and other impurities produced the numerous flaws in the structure which were apparent. In some instances it appeared that the local presence of an excess of manganese interfered with the uniform crystallisation of the carbide of iron areas; in other cases the locally segregated condition of the combined carbon was found to produce brittleness, owing to the lack of a uniformly surrounding and interlocking mesh-work of ferrite. The extent to which segregation may weaken a rail will be understood when it is seen that in some cases no metallic contact was found to exist across the whole thickness of the web.

Such conditions occurring in cross sections of rails, it is evident that longitudinal areas of segregation may occur, and in examining this portion of the subject the cause for segregation appears to be found.

"The segregated state of the chemical constituents sometimes observed in steel rails appears chiefly due to the primarily segregated condition occurring in the top part of the rail ingot. During the slow cooling of ingots, the impurities, such as sulphide, phosphide and silicide of iron and manganese, which freeze or consolidate at lower temperatures, remain liquid or semi-plastic for a longer period of time than the metal itself, and in course of the consolidation of the metallic mass the above impurities, being of less specific gravity, gradually liquate towards the top of the ingot and there chiefly and finally consolidate. Local segregation of the carbon contents also frequently occurs. The impurities appear to liquate towards the central longitudinal axis of pipe of the ingot, near the summit of the ingot, and disseminate themselves amid the intercrystalline spaces of the primary crystals of the steel, and in the vertical transverse section of the finished rail these parts of the ingot are mostly found at the lower part of the rail head, adjacent to the junction of the rail head with the web.

"It will therefore be seen that the top of the ingot is likely to be the place where the greatest local segregation of impurities occurs. There the impurities are more massed together, and in this situation it is probable that the greatest segregation or dissociation of the chemical elements from mass uniformity takes place. The abnormal local concentration, or local aggregation of the chemical elements is thus accounted for. On the rolling out of the ingot into a finished rail this concentrated aggregation, or zone, becomes extended along the interior longitudinal axis of the rail, and in that end of a rail representing the top of the ingot the greatest tendency to internal weakness in segregated rails will be found. The term longitudinal segregation therefore appositely describes such a condition in the composition and structure of a segregated rail."

It has long been understood that the "piping" of ingots makes it desirable that the ends of rails should be cut off, in order that only sound structure may remain in the completed product. The investigations of Mr. Andrews show, however, that a much greater length should be cut off than has heretofore been the practice.

A still better plan may be found in the cutting off of the top of the ingot itself, to ensure soundness and freedom from both segregation and piping voids in the finished rail.

An additional point of interest has been the indication afforded of the relative extent of the segregation of the respective chemical constituents in steel rails, near the end of a rail representing the top of an ingot.

Analysis show that sulphur and phosphorus appear to have the greatest tendency to segregation, and afterwards carbon, though in some instances carbon is capable of heavily segregating. Silicon does not so frequently appear to have segregated heavily, though in some instances it has been observed to have done so. It does not, however, appear that an absolute rule can be established, as local and other special circumstances may induce varied segregated formations.

In addition to the local internal transverse and longitudinal segregation, an external segregation has also been observed. This is also doubtless due to similar causes to those which produce the internal effects.

During the cooling of large steel ingots, in addition to local segregation, near the top of the ingot, there may sometimes be a further transverse migration of the carbon and other elements from the central axial part towards the exterior of the ingot. This tendency to external migration of the chemical elements is most likely to occur near the bottom or wider part of the ingot. Now, when such an ingot is rolled into a rail say 90 ft. long (which is finally cut in 30-feet lengths), that rail representing the bottom of the ingot is likely from the above cause to manifest a condition of local external segregation, as distinct from interior axial longitudinal segregation; whereas, the rail representing the top portion of the ingot would probably afford indications only of internal local axial segregation. Mr. Andrews thinks that the keeping of steel ingots for any lengthened period in soaking pits tends to promote local segregation of some of the chemical constituents.

If either internal or external local segregation arising from any cause is present to any considerable extent, it becomes a serious source of danger, leading to the sudden fracture of rails. An example is afforded by the fracture of a rail on a bridge of one of the chief English railways, which nearly produced a serious accident to an express train. A careful investigation was made into the cause of that accident, which was distinctly traced to an extensive external segregation of some of the chemical constituents of the rail at the point of fracture. Other cases of the fracture of steel rails which have occurred in main line service on various railways, have been investigated, and on careful examination it was found, in many instances, that the cause of the fracture was mainly due to the local segregation of some of the chemical constituents.

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# LONG-DISTANCE TELEPHONY.

## EXPERIMENTAL TESTS OF THE PERFORMANCE OF THE PUPIN SYSTEM ON TELEPHONE LINES IN GERMANY.

*Elektrotechnische Zeitschrift.*

NEARLY two years ago there appeared in the pages of this Magazine an article from the pen of Professor M. I. Pupin, describing the principles upon which his important improvements in long-distance telephony are based. Since that time the system has been acquired by a great commercial company in America, and now, after successfully sustaining the ordeal of exhaustive practical tests, it has been adopted as a commercial system by an important firm in Europe. The tests which were made of the system in the United States were not given to the public, but with a more liberal policy the engineers who conducted the investigation in Germany, Messrs. F. Dolezalek and A. Ebeling, have been permitted to describe their investigations, and from a paper published by them in a recent issue of the *Elektrotechnische Zeitschrift* some account of their work is taken.

The principal feature of the Pupin system lies in the introduction of inductance coils at certain intervals, to reduce the damping constant of the line, the essential point being the fact that the distance between the coils should be a fractional part of the wave length of the alternating current used. Laboratory tests showed that the distance over which distinct telephonic communication can be held may be increased four times without any increase in the conductor, and hence without material increase in the cost of line, and it was to verify this great advantage that the experiments were made over existing telephone lines in Germany.

Messrs. Dolezalek and Ebeling give in their report the mathematical computations showing the relations between capacity, self-induction, and resistance per unit of length of line, and then proceed to show how the introduction of coils in accordance with the theory could affect existing lines. This was made possible by the interested co-operation of the German Imperial Post and Telegraph Office. Two sets of experiments were made. The first of these was upon the cable between Berlin and Potsdam, a distance of 32.5 kilometers, this cable containing 28 double conductors of copper, 1 inch in diameter, provided with paper insulation, and fitted with protection of lead and asphalt. There were 14 of these conductors placed at the disposal of the experimenters, this enabling several multiples of the distances to be tried, while at the same time comparison could be made with the ordinary conductors under precisely similar conditions.

The only change which was made in the conductors for use according to Pupin's system was in the introduction of an inductance coil upon each conductor every 1,300 meters of length, there being 14 coils, one for each conductor, placed in a case and connected at the manholes communicating with the cable. Measurements of the original conductors with a current of 900 periods showed an inductance of 0.0003 henry per kilometer, and the dampening constant was 0.06. By introducing the inductance coils the self-induction was increased 200 times, and the dampening constant diminished to one-sixth.

The results of the experiments with this cable fully confirmed the theory as to the improvement in the transmission of speech. For single lengths of the cable the words were heard far more distinctly and at a much greater distance from the receiver than with the ordinary line. With an increase in the distance, obtained by using two or more circuits the ordinary lines showed a continual weakening in the sounds, until, with five circuits, corresponding to a distance of 162.5 kilometers, speech could hardly be distinguished, although on the lines equipped with the Pupin coils intelligible conversation could readily be maintained. Pushing the trials still further, the lines under test gave audible communication over a distance of 422.5 kilometers.

Experiments were then made with the overhead line between Berlin and Magdeburg, a distance of 150 kilometers. This line was composed of bronze wire, 2mm. in diameter, and before equipment it was compared with a similar line, 3mm. diameter, in the same service, but 180 kilometers long. In this preliminary trial the distinctness of speech over the smaller wire was naturally poorer than over the larger wire. Inductance coils were then placed on the 2 mm. wire, spaced 4 kilometers apart, this being done without interrupting the service, and the result was to render the communication much louder than over the larger wire.

Similar experiments were made over an overhead wire between Berlin and Potsdam, this wire being 2 mm. in diameter, and upon comparison it was found that the communications over this wire in normal condition were about the same as over the 1 mm. wire in the cable, when provided with the inductance coils.

The significant fact about these tests lies in the full proof which they afford of the correctness of Professor Pupin's theoretical computations. In every instance the introduction of coils of the size determined by calculation, at points indicated by the theory, resulted in either a great increase in the volume and distinctness of articulate sounds transmitted, or permitted a corresponding increase in the distance of transmission to be effected. As a result it has become altogether possible to provide entirely satisfactory telephonic communication between Paris and St. Petersburg, or between Berlin and London. An entirely new phase in the development of long-distance telephony has been inaugurated, and important results must certainly follow.

So far as the use of telephone communication upon submarine cables is concerned, the system is theoretically entirely applicable. Its first uses in this department will undoubtedly be in the shorter lines in the Mediterranean, Baltic, and North Seas, so that telephonic communication may be established between London, Copenhagen, Stockholm, etc., with difficulty. Even if telephonic communication is not desired, the introduction of inductance coils will permit the use of high-speed telegraph transmitters upon submarine cables, thus greatly increasing their commercial value.

As to transatlantic telephony, the principal difficulty appears now to be that of placing and securing the inductance coils, but after experience has been had with shorter cables this mechanical problem will doubtless be overcome.

# HIGH-SPEED PUMPS.

### THE DEVELOPMENT OF MACHINERY FOR PUMPING WATER AT HIGH SPEEDS WITHOUT EXCESSIVE SHOCK.

*La Revue Technique—Revue de Mécanique.*

IN the design of machinery for pumping water the inertia of the liquid has always been an important element in the problem, and any sudden changes in direction or velocity of the column of water have been avoided as objectionable and injurious both to the machinery and the pipe line. The usual method of avoiding injurious action from inertia has been to keep within moderate speeds, ordinary practice being to use piston speeds not exceeding 0.40 metres per second (about 80 feet per minute), and not more than 60 revolutions per minute for rotative pumps.

During the past few years, however, these speeds have been greatly exceeded, and it is now well understood that with proper attention to certain details of design, danger from shock both with frequent strokes and high rotations can be avoided.

In a recent issue of the *Revue de Mécanique* this subject of high speed pumps is treated by M. Lecuir very completely, while in *La Revue Technique,* M. Diemer describes some examples of high-speed pumps exhibited at Düsseldorf.

As long ago as 1876 the firm of Farcot designed a pump which operated with a piston speed of 1.80 metres per second (about 350 feet per minute), this result being obtained by a judicious arrangement of the valves and care in the design and position of the air chambers, but notwithstanding the success which was obtained with this machine, the example was not followed at that time.

The real development of modern high-speed pumps dates from 1883, and is a direct consequence of the application of the indicator to the study of the action taking place in the interior of the machine, the indicator having proved as valuable in contributing to the improvement of pumps as it had previously been with the development of the steam engine. The use of the indicator as a means of solving this problem appears to have been first made by Professor Riedler, and in consequence of his investigations it was made clear that the future course of improvement in pumping machinery lay in the adoption of higher speeds, this permitting great reduction in dimensions, increase in capacity, and improvement in operation, due to the smaller masses in operation. Since that time the development of electric driving has created a demand for direct-driven pumps capable of being operated at high rotative speeds, so that the whole question has proved an important one.

The result of the investigation of the action of pumps by use of the indicator revealed several fundamental facts.

1. The influence of the size of the valve seat was found to be far less than had been theoretically supposed to be the case, even with valves which were almost completely balanced.

2. The heaviest shocks were found to be produced by the suction valves.

3. The shocks due to the valves were diminished in proportion as the level of water above the valves in the air chambers was reduced.

4. The magnitude of the shock varied with the weight of the valves.

It is evident that the velocity with which a pump can be operated depends upon the conditions which are necessary to maintain a continuous column of liquid, and that this also involves the necessity of having the valves operate regularly and with a minimum of shock.

Theoretically the valves should operate automatically at the moment when the piston reverses its direction. The movement of the piston, together with the column of water, has gradually been brought to rest; the pressure upon the valve has been gradually diminished, and it should reach its seat just as the plunger attains the dead point.

As a matter of fact these theoretical relations do not occur. The valve is still at a considerable distance from its seat when the motion of the plunger is reversed, and the delay which occurs in its closing produces a shock which depends upon the distance of the valve from its seat, and upon the mass of water which is compelled to make a reverse movement.

Various methods have been suggested to avoid this objectionable action. The most obvious plan is to have the valves operated by positive mechanical connection with the moving parts of the machine, so that they can be set to close at any predetermined point, in a manner similar to the valve gear of a steam engine. This was done by Corliss in a sewage pumping engine at Boston, and a similar construction has since been used with much success by Riedler in various parts of Germany and elsewhere. Riedler has designed pumps operating at 80 revolutions per minute and with a piston speed of 3.45 metres per second (about 680 feet per minute), delivering 16 cubic metres of water against a head of 188 metres, without shock.

While mechanically operated valves are a satisfactory solution of the problem for large and important machines, much progress has also been made in the design of smaller pumps, of which the valves are operated by the action of the water, and which can yet be driven at high speeds without shock. This has been made possible mainly by improved valve construction, and by judicious arrangement of air chambers. The actual weight of the valve itself has been found to be an important element in the retardation of its closing, and lighter valves, closed by springs, have been used. Especial care has been taken with the arrangement of the suction valves, and air chambers on the suction side have been found to be most effective, when properly placed.

M. Lecuir illustrates the importance of the proper action of valves and air chambers by an analysis of a number of pump indicator diagrams, and shows several forms of valve construction which have proved satisfactory in minimising shock at high speeds.

An excellent example of such a form of express pump is found in M. Diemer's description of the Klein pump, exhibited at Düsseldorf, this pump delivering water against a head of 35 metres when running at 170 revolutions, while similar pumps have operated against heads of 60 metres, at a speed of 200 revolutions.

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## ELECTRICITY IN RAILROAD SHOPS.

### METHODS OF EMPLOYING ELECTRIC POWER TO THE HIGHEST ADVANTAGE FOR ECONOMY AND CONVENIENCE OF DISTRIBUTION.

*L. R. Pomeroy—Central Railway Club.*

ELECTRIC transmission of power is now coming to be extensively considered as a desirable method for use in machine shops and manufacturing establishments of all kinds, but in order that its advantages may be fully secured it is desirable that any installation should be made with due regard to the character of the establishment. Thus for some factories the group system offers especial advantages, while in other separate motors for every machine are preferable. Questions of wiring, voltage, kind of motors, etc., may often be best decided according to the methods of work and the nature of the loads, and in every case expert judgment should be passed upon the general arrangement of any installation.

In a paper recently presented before the Central Railway Club, Mr. L. R. Pomeroy discussed the considerations which should apply to the use of electric driving in railroad shops, and as these are similar in many respects to general machine works, his remarks are of wide application and value.

"The mere economy of transmission is one of the least reasons or advantages to be gained by electric driving, as the mere cost of power is but a small proportion of the total cost of operating the shop. The cost of fuel used, on the average, is not over 3 per cent. of the cost of the article produced (labor and other items, in which time is a factor, representing about 47 per cent., and material the other half). Thus it is patent that the power that goes into the product is a small item in itself, and any saving we may effect in that power is not very important. But if, by introducing a system that effects even a small saving in the cost of power, we can produce a saving of from 5 to 50 per cent. in the cost of product turned out, a saving many times as great as the initial saving which brought it about, the subject becomes interesting and worthy of careful consideration. Notwithstanding the foregoing, the power question is worthy of consideration, and what follows is offered as a brief suggestion covering this phase of the question.

"The loss of power from shafting is constant, as long as the engine is running, whether one machine or a hundred be in operation, while the loss of electric transmission is a percentage of the actual power used. For all mechanically driven shops the friction load is a very large percentage of the average load. The friction load depends upon the condition of the shafting, speed, size and number of belts, and the alignment of hangers."

Mr. Pomeroy takes a practical example, and plots curves showing the relation of efficiency to the magnitude of the load, with data enabling mechanical and electrical driving to be compared, the result showing that with electric driving the efficiency is about 68 per cent. at half load, as compared with 30 per cent. for mechanical transmission, while at full load the electrical transmission reached 74 per cent. and the mechanical drive attained only 60 per cent. This gain, however, cannot be expected unless the electrical machinery is carefully selected, although of course an efficiency of 60 per cent. for mechanical transmission is not to be had unless shafting is carefully aligned, belts kept in good order, and lubrication properly maintained, so that both systems are alike in this respect.

A great element in transmission losses is the intermittent character of the load. When the load is maintained continuously at the maximum, a fair efficiency can be secured with mechanical transmission, but such cases are unusual. With electric driving, however, the irregularities in the demand for power have far less effect upon the efficiency.

"There is no consumption of power when the motor and machine are not in operation. There are no power losses when the motor is not in use; no so-called dead load losses, due to mechanical friction of the shafting system; no transmission losses in the line when the electric current is not required. In addition to the foregoing losses due to direct mechanical transmission, there are further losses due to indirect transmission; namely, when the shops are driven by separate engines, each receiving steam through long pipes running from a central plant.

"Loss in steam pipes is frequently the most serious of all, and many times a continuous, loss, night and day. When the pipes are lagged—as laggings in general possess various degrees of efficiency, roughly speaking—the condensation loss amounts to an equivalent in steam of half a ton of coal per annum per sq. ft. of uncovered pipe surface if continually under steam and exposed to the atmosphere, while with the best lagging, the equivalent is one-sixth of a ton.

"When the engines are small and scattered about the works they may consume all the way from 50 to 250 lbs. of steam per indicated horse-power per hour. As it is possible to generate electric power in one centrally located power house, with generators driven by steam turbines of moderate size and at greatly reduced first cost over equivalent reciprocating engines, with a guaranteed steam consumption of from 20 to 22 lbs. per k. w. hour, or 12 to 17½ lbs. per i. h. p., the foregoing figures are significant."

Mr. Pomeroy sums up the advantages of electric driving in much the same general manner as has been done heretofore, laying especial emphasis, however, upon the value of features other than mere efficiency of power transmission. Thus, cost of maintenance, convenience of arrangement of tools, facility in additions and extensions of plant, and convenience in speed variation, all are shown to possess great value in the ultimate efficiency of the plant, and all should be considered in replacing mechanical transmission methods by electricity.

Coming to the especial advantages of electric power in the railroad shop Mr. Pomeroy takes a concrete example.

The Baldwin Locomotive Works claim that the introduction of electricity made a direct saving of 20 per cent. in the pay rolls and 40 per cent. in shop area. The introduction of cranes, made possible by the introduction of electricity, enables the reduction of the laboring force by one-tenth of that previously employed. The advantages of cranes are a legitimate claim in favor of electricity, for the reason that expeditious and efficient cranes are impossible without electricity.

"Presupposing a typical railroad shop comprising several buildings, there are three ways in which electric power may be applied, each varied in the amount of first cost, and the corresponding advantages thereof are directly proportional:

"First—The simplest and most elementary method would be the erection of a central power station, conducting the current to each building and operating by a single motor of sufficient capacity to run the shop.

"Second—The same as in the foregoing, but apply group driving in each shop by a motor for each department or to economical sections of main line shafting. This latter form, like the first, would not demand any re-arrangement in location of tools.

"Third—Same as in case one, but rearrange the tools with reference to departments and locations, providing for a given sequence of work through the shop. Remove overhead shafting and thereby make possible the use of electric cranes where advantageous. Such shafting as necessary to be retained can be carried on brackets to side walls or main columns. Arrange for such a combination of group and individual drives, as will place constant speed tools as far as possible in the groups, and provide individual drives for such tools as demand variable speed or are more or less isolated or used intermittently.

"A shop manager commencing by adopting plan number one would soon see the advantages of plan number two, and the experience with plans one and two would readily lead to a recommendation of plan number three. In addition to the general advantages of electric shop driving, the central power station can provide for shop, station and yard lighting, operating turntables, water and coal stations, without addition to the power station force."

## THE CONTRACT SYSTEM OF WAGES.

### INDUSTRIAL METHODS OF THE BALDWIN LOCOMOTIVE WORKS—CONTRACT AND PIECE-WORK SYSTEMS IN PRACTICAL USE.

*American Academy of Political and Social Science.*

ONE of the largest and most important industrial establishments in the United States is the Baldwin Locomotive Works, and hence such a complete exposition of its industrial and wage system as that given by Mr. Converse in the *Annals of the American Academy of Political and Social Science* demands attention as an important contribution to the subject of applied industrial economics.

Mr. Converse states the gist of the whole question in his opening paragraph:

"The secret of the success of the American manufacturer, that which enables him to turn out a uniformly good article in a short time and at a low cost, lies in the energy of his production. The chief element in this production is the personnel, the character and method of treatment of the labor employed. The American manufacturer has realized the fact that to get the best result and the largest output from his plant the interest of his laborer and himself must be in harmony. This is not a sentimental theory but sound business policy. It is to the advantage of the employer to pay high wages for good work quickly and accurately done, rather than to pay low wages for slow and slovenly work. The laborer does better when he realizes that his work is appreciated and that increased effort and diligence meet with substantial recognition and reward. The workman is encouraged to exercise his brain and is given extra pay or promoted for having done something or discovered something to the advantage of his employer."

From the first organization of the works, about fifty years ago, the product of the works was arranged according to a classification which, with necessary modifications has been continued down to the present time. In this system the various types of engines built are grouped according to certain salient features involved in their construction, primarily based upon the number and arrangement of the driving and truck wheels, and the size and number of the cylinders. The general principle resembles that used in botanical scientific nomenclature, the locomotives being reduced to their genus and species by means of a combination of figures and letters which indicate the total number of wheels under the engine, the number of driving wheels, the diameter of the cylinders, and whether they are single-expansion or compound. All the work upon each type of engine is kept under this unit system of classification, including designing, drawing, purchase of materials, and time recording.

"A further advantage of this unit system of production appears in the accounting department. Two sets of books are kept—a financial and a manufacturing set. In the financial department accounts are kept of sales, purchases and expenditures. In the manufacturing books a separate account is opened with each locomotive and the material entering into its construction and the labor expended on it are charged against that locomotive. At the end of the year these two sets of books must balance each other. By this method the actual cost of each locomotive is obtained with accuracy and, allowing for fluctuations in price of raw materials, correct quotations can be made for any class of engine.

"It is upon this unit system of locomotive classification, by means of which the identity of each locomotive is preserved, that the system of the labor organization and management of the establishment is based."

Since about thirteen thousand men are employed at the establishment, the question of labor management is an important one, and the variety of work carried on renders the shop more general in its character than might at first be supposed. Thus the skilled labor includes iron-founders, brass-founders, blacksmiths, machinists of all kinds, woodworkers, tinners, carpenters, painters, copper-workers, plasterers, and sheet-iron workers. About two-thirds of the men are skilled mechanics and one-third unskilled laboring force. These men have their wages reckoned by the hour, the average being 30 cents per hour for skilled labor and 16 cents for unskilled labor. By far the greater portion of the work, however, is paid for at piece rates, the unit system of production making it desirable that all work should be turned out by the piece.

"In the Baldwin Locomotive Works, two forms of piece-work are represented, viz: Piece-work proper, where the workman is paid according to the quantity produced; and a contract system, where sub-foremen, called contractors, are entrusted with the execution of a portion of the work on a locomotive; for example, the entire construction of the cylinders, or the erection of a certain number of tanks. The contractor has entire charge of the job, seeing that the raw material is delivered in time, that the men are prompt and diligent, that tools are in repair and machines do not break down. The contractor is paid for the job, the firm paying directly to each workman for the labor on the job. The contractor cannot, therefore, get more than the amount due him on any one job by curtailing the wages of his labor. The contractor is a piece-worker on a larger scale. As he is paid by the job, he has an incentive to turn out his work as quickly as possible and to get as much work as possible out of the men under him."

Apart from the incentive to the men to make the maximum output under the piece rate system, the saving in time in other respects is noteworthy. Time is economized everywhere in handling materials, and in passing work in progress from one department to another, and when any interruption or breakdown occurs the workmen are more interested than any one else in a speedy resumption of operations.

"The contract and piece-work systems insure quantity of product; a rigid system of inspection insures quality of product. In order to insure good workmanship an extremely rigid system of inspection is maintained and contractors and piece-workers are held to strict account if the quality of their work falls below the standard.

"Another feature of the piece-work system, which is at the same time an advantage and a disadvantage, is the specialization which it naturally entails. In the kind of machine work done at the Baldwin Locomotive Works, the same operation is performed over and over again many times. The piece-worker, doing the same thing repeatedly, soon finds out the best and quickest way to do the work and, as he can make more money doing his specialty, he is naturally unwilling to be shifted to another machine or another class of work."

Since the high degree of specialization

tends to prevent the development of general mechanics, the company has established a special system of apprenticeship, under moderate pay, but with especial opportunities for learning the trade.

"The policy of the firm is to make the interest of the men identical with its own. Hard work is required but high wages are paid, ingenuity is encouraged, and intelligent and faithful work is liberally rewarded. Piece-rates are seldom cut, and then only on account of the introduction of a time-saving tool in which case the workman shares in the gain accruing. The policy is to maintain a uniform piece-rate for all the men doing a certain class of work. If one man shows especially marked ability, he may be shifted to another job; usually being made a contractor or sub-foreman. The policy of the establishment is to make promotions from within, foremen, bosses or superintendents are not imported. There are no hereditary rights to important positions."

The criterion of the success of the system is the fact that it has persisted through a long period of years, and that labor troubles are practically unknown in the works. Many of the men occupying high positions in the establishment, and several members of the firm have risen from the ranks of the workmen, while the commercial development of the works is sufficient evidence of the wisdom of its management.

## THE THEORY OF ELECTRONS.

### MODERN RESEARCHES INTO THE THEORY OF THE NATURE OF ELECTRICITY AND ITS RELATIONS TO MATTER.

*Sir Oliver Lodge—Institution of Electrical Engineers.*

THE applied science of engineering has always been obliged to proceed in its work with but an imperfect knowledge of the materials with which its work is done, and with but few exceptions the theory has been developed largely from the data acquired in the course of practical work. When, by some especially brilliant deduction, a scientific man produces from theoretical considerations alone, a detailed practical application of scientific principles, the feat is hailed with an admiration which clearly shows its unexpected nature, and in many instances the really practical work of such men as Faraday, Maxwell, Mayer, Thomson and others, is often considered mere theory until some subsequent experience shows how practical it really was.

Thus, electrical engineers have pushed their practical work to a high state of development, producing generators and motors possessing efficiencies far surpassing anything which has been attained in the older science of steam engineering, while at the same time using the old and acknowledged imperfect theories of electricity, and constantly admitting their ignorance of its true nature. At the same time the physicists have been active in studying the observed phenomena and deducing from the results of this practical work theories which accord more and more completely with the facts. The result has been the development of the hypothesis of electrons, a step toward a working theory of electricity which has hardly been appreciated by practical electricians because of their imperfect acquaintance with its principles.

For these reasons the important paper of Sir Oliver Lodge, upon the subject of Electrons, presented before the Institution of Electrical Engineers, and published in full in the *Electrician*, demands especial attention, placing, as it does, the elements of theory in a manner adapted for the intelligent study of the general reader as well as the student of physics.

Starting with the electrostatic conditions surrounding a charged sphere, with its radiating lines of force, the phenomena which accompany its movement through the ether are considered; the combination of lines of electric force and the motion, producing new lines of magnetic force, these latter, unlike the lines of electric force, being curves. The magnetic field comes into existence when the charged body begins to be moved, and dies away as it comes to rest, its strength depending upon the potential of the electric charge. When the motion of the body is being accelerated there is an increasing current, with self-induction and an electromotive force which opposes the motion; when the motion is decreasing there is an electromotive force in the same direction, tending to increase the motion. The phenomena are similar in character with those of inertia, and it is not improbable that they are identical with it. Whatever inertia a material sphere may have considered as matter, it will possess more when it is charged with electricity, and the amount of extra or electrical inertia is proportional to the electrostatic energy of the charge.

Now in order to confer upon any electric charge an appreciable mass, it is necessary to make its potential extremely high—that is to concentrate it upon a very small sphere. By observation, however, the charge on an atom, as determined in electrolysis, is so small that if it were distributed uniformly upon a sphere the size of an atom its potential would be only about 3 volts, and the inertia of a body possessing the corresponding energy, when moving at the speed of light, the minimum speed at which radiation could be produced, is so minute that the charge, when distributed over an atom would add no appreciable fraction to its apparent mass. If, however, the size of the sphere be still further diminished, the potential will be correspondingly raised, so that the requirement for the existence of a charge corresponding with observed effects is that of a body much smaller than any existing atom.

Taking the charge of a monad atom as the unit electric charge, we have the possibility of considering the charge apart from the atom as a natural unit of electricity. The atom with its charge is called an ion. The charge, considered alone, without its atom, is called an electron, or natural electrical unit. This is the smallest known portion of electricity, of which we can have multiples, but of which it is impossible to have fractions. Every atom carries a definite charge, the monad atom one, the dyad atom two, etc., but none of them carries a partial charge.

It is therefore seen that we have deduced, from the measured effects of electrical inertia, the probability of the existence of ultimate particles of electricity, so minute that they may pass freely between the spaces between the ordinary atoms of matter, and which in fact may themselves form the ultimate constitution of matter.

Already the modern theory of chemistry has become greatly modified by reason of the study of the electron hypothesis, and it is possible that from it also it may become possible to explain the phenomena of gravitation and cohesion. The lines along which such investigations must be carried are well indicated in the exceedingly able address of Sir Oliver Lodge, and in spite of the p rofound nature of the reasoning, it is a most fascinating phase of that pure science which may become the practical work of the impending future.

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# SUPERHEATED STEAM.

## A REVIEW OF CURRENT PRACTICE IN THE UNITED STATES IN CONNECTION WITH STEAM ENGINE DESIGN AND OPERATION.

*Ernest Foster—Engine Builders' Association.*

THE advantages of superheating as a means of preventing condensation losses in steam engines are now well understood, and it is only an apprehension of mechanical difficulties which prevents a more general adoption of this obvious element in steam economy.

At the recent convention of the Engine Builders' Association of the United States, Mr. Ernest Foster discussed the question from the practical side, and some abstracts of his remarks may be found useful.

Mr. Foster distinguishes between moderate superheat, and highly superheated steam, and shows the extent to which superheating may conveniently be carried without involving operative difficulties with engines designed substantially in accordance with present practice.

"By a moderate superheat, we mean from 100 to 150 degrees at the boiler, which should give in the neighborhood of 100 degrees at the engine and be sufficient, with proper protection, to carry the steam nearly, if not quite, through one cylinder without condensation. If the engine is compound, the steam, having lost its superheat at the terminal point of the high pressure cylinder, is re-superheated about 100 degrees in a reheater between the high and low pressure cylinders and again loses its superheat while expanding into the low pressure cylinder, arriving at the point of exhaust with the temperature of saturation. This arrangement may be considered at the present time as the best which can be proposed. The amount of superheat is so moderate as not to require anything more than good construction for modern high steam pressures."

When higher degrees of superheating are used it will generally be found necessary to make modifications from the usual details of engine design. On the high-pressure cylinders of compound engines at least, sliding valves should be avoided, and poppett valves employed, as the high heat is apt to distort the valve and seat and cause binding with valves of the Corliss type, although Mr. Foster believes that properly designed Corliss valves may be used at high temperatures. At the same time the advantages of extremely high superheating are not such as to render its use desirable, except under special conditions. Probably the best method of employing highly superheated steam is in a steam turbine of the De Laval type in which the absence of valves and the freedom from lubrication remove the principal difficulties otherwise encountered.

"In the present state of the art it would seem that the condition most attractive to American engine builders would be one of moderate superheat. We thus confine ourselves to a conservative policy and avoid the necessity for making any special provision for extremely high temperature. We use lubricants, and gaskets and packing which may be obtained in the open market at a reasonable cost, while at the same time we avail ourselves of such positive and direct benefits of superheating as: Dry steam in the pipes and throughout the engine, elimination of separator, low steam consumption per unit of work done, smaller steam pipes and ports, simplified system of steam jackets, greater amount of work done per boiler capacity, and efficiency at light loads. These are all practical and common sense improvements, and are of such proportion as to fix our attention."

An important element in the question of the introduction of superheated steam is found in the modifications possible in the steam ports and pipes. The absence of entrained water and the diminished density of an equal volume as compared with saturated steam permits a reduction of about 20 per cent. in the size of the steam pipe; and the velocity of the steam in the pipes should be kept up to about 6,000 feet per minute.

"It must not be considered necessary to make any very extensive preparations for the use of superheated steam, it may almost be said that the requirements are merely in the line of good practice, and, as such, should be inaugurated in any event.

It is important to have the joints of the steam pipes firmly made and well bolted; corrugated brass gaskets are usually found very satisfactory with superheated steam. Provision must, of course, be made for the expansion and contraction of the steam lines to a somewhat greater extent than ordinarily, and the steam pipes as well as the flanged unions should be covered with a good non-conducting material in a thick layer. It is important to have the flanged unions covered as well as the pipe. With proper precautions of this sort and with a velocity of steam in the pipes of from 4,000 to 6,000 feet per minute, the drop in temperature per foot of run may easily be kept down to 1 degree in 6 or 7 feet of length."

The manner in which Mr. Foster views superheating is practically what might be expected from the conservative position of a modern builder of steam engines of good design, or of an engineer following good standard practice. Superheating was tried many years ago, and failed to come into use simply because the engines of that day were not suited for it. Now steam engineering practice has advanced, and moderate superheating may be used with success and advocated with safety, since it does not involve any radical changes in design. With the more general introduction of the internal combustion engine for all sizes and services, the question of high cylinder temperatures will become a matter of common practice, while, if the steam engine is to hold its own in competition with the more economical motor something must be done to advance its performance.

Higher pressures and higher temperatures appear to be the only resources left in the line of improvement in steam using practice, and the necessary modifications in engine design will surely come with the demand. It is more than probable that the reciprocating engine with its close fits, and sliding surfaces, will in many instances be replaced by the steam turbine, driving the direct-connected dynamo, the power being distributed and applied electrically to the best advantage, and with greatest convenience.

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# THE ENGINEER OF THE TWENTIETH CENTURY.

### HIS RELATION TO PUBLIC AFFAIRS AND TO INDUSTRIAL ENTERPRISE—UNITED ACTION AND CO-OPERATION ESSENTIAL.

*Chas. F. Scott—Engineers' Club of Philadelphia.*

At the twenty-fifth anniversary of the Engineers' Club of Philadelphia, Mr. Charles F. Scott spoke of the engineer of the twentieth century and made some suggestive points with regard to the extention of the scope of engineering and its growing connection with industrial progress in a very interesting manner.

Referring back to the work of the engineer in the last century, Mr. Scott showed that the great discovery of the nineteenth century was co-operation, the effectiveness of concentration, the efficiency of largeness. Says he:

"Compare the old days of the hand loom in the home, of the shoemaker at his bench, of the individual oil well and coal mine, of the small railroad and of the small factory, —compare these with modern methods, with their unbounded possibilities—possibilities of good and possibilities of evil; of good, because the engineer has provided the means for doing the world's work more efficiently; of evil, because the social, the industrial, the commercial systems have not kept pace with the advance made by the engineer—for they are tainted by injustice and by selfishness."

Viewed in the light of what has been done, the work of the engineer in the present century may be predicted with partial accuracy at least. He is to become the great factor in adjusting and operating the intricate mechanism of a new civilization. He is to deal with large affairs in a large way. He is to be closely related to every department of modern life. He will be advanced to administrative positions for which his knowledge and his training peculiarly fit him. Even at the present time we see this phase of his career developing. The heads of great railways, of large commercial undertakings, of vast enterprises of today are in many cases engineers who from their proved capacity to manage men and materials in special lines have been entrusted to control broader and more general affairs.

All of this development means a fuller recognition of the position of the engineer by the world at large. Even yet the so-called learned professions fail to realise that the engineer may be a man of higher educational attainments and wider social grasp than is possible under the old scholastic limitations. It has been well said that of the three professions, the lawyer thrives by our quarrels, the physician by our diseases, and the clergyman by our sins; but the engineer in his work appeals to the higher and broader benefit of the human race by directing the great sources of power in Nature to the use and convenience of man.

An important element in the progress of the engineer in the nineteenth century has been the work of the various engineering societies, and this is certain to become of still more influence and effectiveness in the present century. This phase of the life of the engineer will also doubtless be modified in the light of general progress. The present state of affairs in this respect Mr. Scott well likens to the relation of the original American states before the union was effected. By forming a union the several states which now form the great nation have lost nothing of their individuality, while gaining immeasurably in power and effectiveness.

Already there has been some indication of the manner in which this important step forward may be accomplished. During the past year the four great national societies united in the foundation of the John Fritz medal, as an honor to one of their own number and an incentive to individual effort of all their members. One of the most interesting things about the conduct of that undertaking was the revelation which it made to all of the unity in purpose and methods of the several societies. Mr. Scott but expresses the thought of many of those who took part in that foundation, when he said:

"In the vision of the future may we not discern a reflection of the John Fritz medal in the larger life of the twentieth century engineer? Methinks I see the outlines of the medal taking the form of a magnificent building, the capitol of American engineering. Into this home in the metropolis are gathered the great engineering societies from their scattered lodgings. Here is a great technical library, here are ample assembly halls and comfortable parlors, here are the headquarters of a score of lesser societies, affiliated in their work but restricted in their scope. I see all over the country innumerable local societies and engineering clubs, no longer isolated but joined together into one great combination. I see them affiliated with the national bodies—sometimes as local chapters—all together constituting a great union. There is individual freedom but general co-operation. The Engineering Congress representing all the engineering professions and supported by the great union of enginering societies, gives to engineers a rank consistent with the importance of their work; it increases the efficiency of the inter-relations among engineers. An eminent body, it is powerful in advancing the common interests of engineers, and it represents the engineering profession in its relation to other professions, to pure science, to education, to legislation, to public improvements and to the general welfare."

There is nothing to hinder the early realization of this thought but the inertia of the societies themselves, and with the growth of the progressive spirit, and the full realization that union in this broader plane does not involve the relinquishment of the slightest element of present independence, any such opposition must ultimately be overcome. Of all men the engineer has the least occasion to be jealous or suspicious, for he, more than any other has to deal with materials and conditions which permit of no deception or false assumptions.

"The men who are mastering the powers of nature will yet rise in the strength of united effort to meet the increasing responsibilities of the coming years. For it is theirs to build the foundation of the new civilization; it is theirs to establish material prosperity—the underlying condition for broader, fuller and higher life."

## THE ENGINEERING DEVELOPMENT OF AFRICA.

### PROGRESS OF RAILWAY CONSTRUCTION—REGULATION OF THE NILE—DEVELOPMENT OF MINERAL WEALTH.

*Geological, Physical, and Political Studies.*

AFRICA has been the field of many invasions, all of them military, and after each of these attacks there has been a lapse into barbarism and darkness. Now, however, a new order of subjugation has been commenced, an attack of a kind which has not yielded to the lapse of time in other parts of the world, and which can be depended upon to produce lasting results in the opening of the continent—the attack of the engineer. At the present day railways advance nearly as rapidly as the columns of an army formerly progressed, and where they go they stay. The extraction of the wealth of the earth enriches the country instead of impoverishing it as does the loot of the invader! while the fortifications which the civil engineer constructs to oppose and control the flood of great rivers provide a far greater protection to the land than any structure ever erected by his military associate.

The question of the engineering development of Africa forms the subject of more than one important article in recent issues of technical journals. In the *Revue Générale des Sciences* appears an extended study of the mineral resources of the continent, by M. L. de Launay, while in the *Zeitschrift des Oesterreichischen Ingenieur- und Architekten Vereines* Dr. Franz Ritter v. Le Monnier discusses the entire subject of the railways of Africa, present and prospective. The great Nile dam at Assouan has been fully discussed in the British journals, notably in the *Engineer* and in *Engineering*, while industrial conditions in various parts of the continent have formed the theme of correspondence and discussion in many publications. To review all this mass of information would be far beyond our space limitations, but some of the salient features in this attack by the engineer upon the section of the world which has thus far resisted all other invasions may be found practicable.

So far as mineral wealth is concerned, it is known that Africa contains great riches, but until a geological survey can be made much depends upon conjecture. M. de Taunay gives a summary of the geology of the continent, so far as it is known at present, and shows that it may be divided into two main divisions: one of which consists in its latest strata of the carboniferous formation, covering horizontal strata of permo-trias, while the other exhibits principally formations of the tertiary period. These he examines at length, showing the difference between the alluvial deposits of the gold coast and the conglomerate formations of the Witwatersrand, and discussing the possible origin of the deposits and the necessity of further geological studies in this respect.

The Congo region, and in fact the whole equatorial portion of the continent appears to have no gold whatever, the auriferous regions appearing to be in two zones, one between 5° and 10° north latitude, and the other between 15° and 25° south. In the equatorial region the principal deposits are iron and copper, with traces of tin.

The formations of the Witwatersrand have been more fully studied than any others, and the whole of South Africa, up to the great lakes may be considered as possibly auriferous. Besides the metalliferous deposits extensive deposits of coal are indicated, and these will doubtless be developed hereafter. The northern portion of the continent, known more fully from earlier times, contains deposits of copper, zinc, and lead, as well as of nitrates and phosphate rock, these having been worked but superficially down to the present time.

The development of the natural resources of the continent, however, must depend largely upon transport facilities, and hence the progress of railway construction forms the most important element in the work. Already much progress has been made in this work. Dr. Ritter v. Le Monnier gives a summary of the state of the railways of Africa at the close of 1900, the total being 12,500 miles, of which nearly one-half is in British colonies, one-fourth in French colonies, and more than one-fifth in Egypt, the small remainder being in the German and Portuguese colonies, and on the Congo. These various roads all penetrate into the continent from the sea coast, and it is evident that such operations must do far more to open up the continent than any Cape-to-Cairo railway could do. The Uganda railway, the lower Congo line, and the proposed line across the continent, all should prove effective means of permitting that development which naturally follows the creation of transport facilities, and the connection of the interior with the coast.

Among the undeveloped resources of the continent of Africa there are numerous sources of hydraulic power, which, when equipped in the light of modern experience, should do much to aid in the work of subduing the country and making its natural riches available. These need only access, such as the completion of rail and water communication will provide, to render them most efficient aids in the work to be accomplished.

The completion of the Nile dam at Assouan has been the occasion of numerous articles, and it can be mentioned but briefly here. In fact it is a much more extensive scheme than the mere construction of a regulating dam across a river, even though the dam be a mile and a quarter long, and the river be the Nile. It means, in fact, the impounding of the waters of the Albert and the Victoria Nyanza, at the sources of the White Nile and of Lake Tana at the source of the Blue Nile, as main reservoirs, with the new storage reservoir above the dam as an artificial auxiliary. Constructed under the most difficult conditions, with the constant action of the river to be opposed, and with many local and unforeseen obstacles to be removed, the Assouan dam, and its supplementary barrage at Assiout to divert the water into the irrigation canals, forms not the least striking of the means by which the engineer is subduing the continent of Africa permanently to civilization.

# THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

*We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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## CIVIL ENGINEERING

### BRIDGES.

**Arch.**

Kinematic Investigation of a Two-Hinged Semi-circular Arch (Kinematische Untersuchung eines Halbreisformigen Bogenträgers mit Zwei an den Kämpfern Gelegenen Gelenken). G. Ramisch. A mathematical study of an arch with hinges at the springings, using the elastic theory and the methods of kinematics. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 28, 1902. No. 52417 B.

The Monumental Bridge at Luxembourg (Le Pont Monumental de Luxembourg). M. Cart. A description of the great arch of 84 metres span; one half of which is already completed. Illustrations showing the state of the work are given. 3000 w. Rev Gen des Chem de Fer—Dec., 1902. No. 52452 H.

**Foundations.**

The New York Tower Foundations for the Manhattan Bridge. Briefly describes the work giving the specifications for the caissons. 2400 w. Eng News—Nov. 27, 1902. No. 52035.

**Hinged Arch.**

The Two-Hinged Arch. Edward Godfrey. An analytic method for finding the stresses in a two-hinged arch, based on the "pull over E" formula, that is, the formula for finding deflections; with diagrams and table. 2200 w. Eng Rec—Dec. 27, 1902. No. 52576.

**London Bridge.**

The Widening of London Bridge. Describes the temporary work, which is of an unusual nature, and the way in which it has been carried out. Ill. 1700 w. Engng—Dec. 5, 1902. No. 52364 A.

**Masonry.**

Construction of the Blackwell's Island Bridge Masonry. An illustrated article describing the methods of work, materials, method of preparing and handling, etc. 4300 w. Eng Rec—Dec. 16, 1902. No. 52345.

**Removal.**

Removal of the Old South Tenth Street Bridge, Pittsburg, Pa. Willis Whited. Gives a brief account of the bridge and describes the method of removal. 1300 w. Eng Rec—Nov. 29, 1902. No. 52124.

**Suspension.**

The Construction of Suspension Bridge Cables. An editorial review of the history of cable construction, particularly the attempts to improve upon the parallel wire cable. 1500 w. Eng News—Nov. 27, 1902. No. 52034.

**Swing Bridge.**

A 128-ft. Wooden Swing Bridge Over Barnegat Bay, Mantoloking, Ocean County, N. J. Franklin Van Winkle. Brief illustrated description of a bridge having wooden draw span possessing novel features. 3300 w. Eng News—Nov. 27, 1902. No. 52032.

## CANALS, RIVERS AND HARBORS.

**Coffer Dams.**

The Construction and Use of Coffer Dams (Des Batardeaux et de Leurs Epuisements). M, Arana. Discussing methods of construction of coffer dams in connection with river improvement works, and especially with the pumping of the water from them. 3500 w. Revue Technique—Nov. 25, 1902. No. 52428 D.

**Dams.**

A New Dam and Storage Reservoir at Amsterdam, N. Y. An illustrated description of a curved dam, 450 feet long, with a cement masonry core wall 63½ feet high, making a reservoir with an area of 180 acres and a capacity of 1,200,000.000 gallons. 1500 w. Eng Rec—Dec. 27, 1902. No. 52575.

The Assouan Dam and the Assiout Weir. A general history of these great reservoir works on the Nile, with illustrations. Serial Part I. 2000 w. Engr, Lond—Dec. 12, 1902. No. 52539 A.

The Aswan Dam. An editorial review of this great engineering work for regulating the flow of the Nile and supplying irrigation water. 3000 w. Engng—Dec. 12, 1902. No. 52564 A.

The Muscoot Dam in the Croton Valley, New York. An illustrated description of a masonry dam, 950 feet long, being constructed near the middle of the projected Croton Lake, so that the bottom of the upper end of the lake will not be exposed at low water. 1200 w. Eng Rec—Dec. 20, 1902. No. 52568.

**Danube.**

The Regulation of the Danube in Hungary (Die Regulierung des Donaustromes in Ungarn). Karl Grünhut. An exhaustive study of the various states of the river, with diagrams of the water levels and data concerning the regulation works. Three articles. 15,000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Nov. 14, 21, 28, 1902. No. 52415 each B.

**Floods.**

Protecting a Railroad from Flood Currents. Day Allen Willey. An illustrated description of a piece of revetment along the Missouri River, which has attracted attention on account of the plan of construction, low cost, and permanent protection afforded. 1200 w. Sci Am—Nov. 29, 1902. No. 52045.

**Ligthouse.**

The New Beachy Head Lighthouse. Illustration and brief description of a recently completed lighthouse on the English Channel. 500 w. Sci Am—Nov. 29, 1902. No. 52043.

**Overflow.**

The Mareosiphon (Le Mareosiphon). G. Willems. A description of a form of siphon overflow for the relief of low lands from tidal submergence. 3000 w. 1 plate. Ann des Ponts et Chaussées—2 Trimestre 1902. No. 52449 E+F.

**Panama Canal.**

Lake Bohio, the Summit Level of the Panama Canal. George S. Morison. An authoritative exposition of the project adopted by the American Isthmian Canal Commission for the control of the summit level. 4000 w. Engineering Magazine—January, 1903. No. 52485 B.

**Tunis.**

The Port of Bizerta (Le Port de Bizerte). Col. G. Espitallier. A description of the harbor of Bizerta in Tunis, showing the important improvements which have taken place between 1881 and 1900. Three articles. 7500 w. 1 plate. Génie Civil—Nov. 15, 22, 29, 1902. No. 52422 each D.

**Weirs.**

A Study of Hydraulic Coefficients (Eine Studie über Hydraulische Coëfficienten).

H. Heyne. An examination of the various formulas for the flow of water over weirs, showing the discrepancies, and discussing the extent to which the usual coefficients may be used. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 5, 1902. No. 52420 B.

## CONSTRUCTION.

**Building Construction.**

Influences Affecting Modern Building. Cyril Blackel. Read before the Inst. of Archts. of N. S. W., Sydney. Compares the materials in present use with those of one hundred years ago, discusses the sewerage systems, steel work, gas, electricity and other influences that have affected design. 3500 w. Archt, Lond—Nov. 28, 1902. No. 52169 A.

**Columns.**

The Dimensions of Centrally and Eccentrically Loaded Columns (Einige Bemerkungen über die Bestimmung der Abmessung exzeutrisch und Zeutrisch Beanspruchter Säulen). A. Ostenfeld. A review of Tetmajer's recent treatment of the subject, deriving coefficients for various sections. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 6, 1902. No. 52410 D.

**Dredge.**

Dredges for Levee Building. Enos Brown. Illustrated description of a giant dredger. The bucket holds 25 tons, and the boom is 155 feet long. 500 w. Sci Am—Dec. 20, 1902. No. 52394.

**Fire-proofing.**

Fire-proof Grain Storage Buildings. Illustrates and describes several types tracing the evolution of fire-proof tank elevators. 2800 w. Br Build—Nov., 1902. No. 52096 D.

Floor Construction and Fire-proofing in the Government Printing Office, Washington, D. C. An illustrated description of the construction work of this new building, which is being built under an appropriation of $2,429,000, which must include the equipment. 2000 w. Eng Rec—Dec. 6, 1902. No. 52244.

**Floors.**

Static and Dynamic Load Tests of De Valliere Fireproof Floor Construction. E. S. Powers. Explains the methods of construction and gives the results of statical and drop tests. Ill. 1400 w. Eng News —Nov. 27, 1902. No. 52031.

**Foundations.**

See Civil Engineering, Bridges.

**Government Buildings.**

The Relation of the Architect and Engineer to the Design and Erection of Government Buildings. John Stephen Sewell. From a paper read at the convention of the Am. Inst. of Archts. at Washington. Discusses their relative positions and the need of improving the system of the construction of these works. 2000 w. Eng News—Dec. 18, 1902. No. 52513.

**Masonry.**

See Civil Engineering, Bridges.

**Reinforced Concrete.**

See Civil Engineering, Materials.

**Roads.**

Roads. John Price. Extract from address before the Birmingham students of the Inst. of Civ. Engrs. Considers the various kinds of pavements, the standard of economy, gradients, cost, etc. 1500 w. Quarry—Dec. 1, 1902. No. 52301 A.

**Simplon Tunnel.**

The Construction of the Simplon Tunnel (Der Bau des Simplon-Tunnels). Paul Möller. A very complete description of the project, its execution down to the present time, and the methods employed in boring and conveying material; with many illustrations. 7500 w. Zeitschr d Ver Deutscher Ing—Nov. 15, 1902. No. 52,400 D.

**Steps.**

How to Lay Portland Cement Steps, Curbs, and Similar Structures. F. H. Crafts. Directions, with illustrations of tools used. 1100 w. Munic Eng—Dec., 1902. No. 52085 C.

**Wind Pressure.**

The Effect of Wind Pressure on Structures. R. M. Neilson. A discussion of the principles upon which the strength of structures exposed to wind should be proportioned, with data from the most recent experiments and authorities. 4500 w. Engineering Magazine—January, 1903. No. 52489 B.

## MATERIALS.

**Cement.**

The Portland Cement Industry (L'Industrie du Ciment Portland). E. Candlot. A general account of the method of making Portland cement with illustrated descriptions of works in various countries. 10,000 w. Bull Soc d'Encour—Nov. 30, 1902. No. 52434 G.

**Clay.**

An Unrecorded Property of Clay. H. J. Cambie. On the loss of its cohesive properties, if dried sufficiently to remove all its moisture. 1000 w. Can Soc of Civ Engrs—Adv Proof—Dec. 4, 1902. No. 52-288 D.

Researches upon the Plasticity of Clay (Recherches sur la Plasticite des Argiles). B. Zschokke. An exhaustive study of clays, and their uses in the arts. 12000 w.

Bull Soc d'Encour—Nov. 30, 1902. No. 52434 G.

**Corrugated Iron.**

Practical Applications of Corrugated Iron (Etude sur l'Emploi Pratique des Toles Ondulées). J. E. Delluc. With especial reference to the uses of corrugated iron for roofs and sides of buildings, with details of methods used in France and data of standard French sizes. 1500 w. Revue Technique—Dec. 10, 1902. No. 52431 D.

**Plates.**

Experiments on Sheet Iron Plates (Expériences sur des Bordages en Tôle). M. Galliot. Data and results of tests on flat and buckled plates of sheet iron under hydraulic pressure, with formulas deduced from the experiments. 3000 w. 1 plate. Ann des Ponts et Chaussées—2 Trimestre, 1902. No. 52450 E+F.

**Reinforced Concrete.**

Compressive Resistance of Concrete-Steel and Hooped Concrete. A translation of an important paper by M. Considère, in *Le Génie Civil,* and in *Beton und Eisen,* on his recent experiments on concrete-steel in compression, showing the superiority of reinforcing concrete prisms by wire wound helically. Two articles. 6500 w. Eng Rec—Dec. 20, 27, 1902. No. 52-570.

Concrete Piles of the Hennebique System. Illustrated abstract of a paper by Leopold Mensch before the Civil Engineers' Club of Cleveland, Ohio, describing solid reinforced concrete piles on the Hennebique system. 600 w. Eng Rec—Dec. 27, 1902. No. 52583.

Loading Tests of Ransome Concrete-Steel Floor Construction. An illustrated account of comparative tests of full-size floor panels, of different spans and construction, made for the Building Department of the Borough of Richmond, New York City. 1200 w. Eng Rec—Dec. 20, 1902. No. 52569.

Monier Concrete-Steel Storage Tanks for Portland Cement; Illinois Steel Co. Brief illustrated description of four bins or tanks constructed in South Chicago, Ill., having a total capacity of 25,000 bbls. 1000 w. Eng News—Dec. 11, 1902. No. 52351.

The Resistance of Reinforced Concrete to Flexure (Résistance et Déformations du Béton Armé Sollicité à la Flexion). F. Schüle. A complete account of exhaustive tests made at the Zurich Polytechnic, using the Amsler testing machine and the Bauschinger mirror apparatus. Three articles. 8000 w. Schweiz Bauzeitung, Nov. 29, Dec. 6, 13, 1902. No. 52-461 each B.

The Theory of Structures of Combined Concrete and Iron (Zur Theorie der Verbund Kôrper aus Beton und Eisen). K. Haberkalt. A mathematical discussion of the theory of reinforced concrete structures; with practical applications. Two articles. 7500 w. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 29, Dec. 6, 1902. No. 52484 each D.

## MEASUREMENT.

**Moment of Inertia.**

A New Method of Calculating the Moment of Resistance and the Moment of Inertia (Nouvelle Méthode pour le Calcul du Moment de Résistance et du Moment d'Inertie). M. Lathuillière. Deriving a method especially applicable to built-up beams and girders, materially reducing the labor of computation. 2500 w. Revue Technique—Dec. 10, 1902. No. 52432 D.

Moments of Inertia. R. M. Neilson. The first of series of articles aiming to render the question of moments of inertia clear to those who have been perplexed. 800 w. Prac Engr—Nov. 28, 1902. Serial. 1st part. No. 52253 A.

**Surveying.**

The Hammer-Fennel Tachymeter-Theodolite (Der Hammer-Fennel'sche Tachymeter-Theodolit). Edouard Dolezal. Describing an improved form of stadia apparatus, with examples showing its accuracy and convenience. 3000 w. Zeitschr Oesterr Ing u Arch Ver—Dec. 5, 1902. No. 52419 B.

See Mining and Metallurgy, Mining.

## MUNICIPAL.

**Aldershot.**

Recent Municipal Works at Aldershot, England. Nelson F. Dennis. Abstract of paper before the Assoc. of Municipal and County Engineers, describing the sewage works, refuse destructor, electric works, etc., of this great military camp. 2000 w. Eng Rec—Dec. 27, 1902. No. 52582.

**Explosives.**

Proposed Rules to Govern the Storage and Use of Explosives in New York City. Gives the important features of rules formulated by the Municipal Explosives Commission appointed by the Mayor. Also editorial. 4300 w. Eng News—Dec. 18, 1902. No. 52516.

**Habana.**

Sanitary Condition of Habana. Report tending to show that the healthy conditions brought about by thorough cleansing and inspection system are relaxing and there is a danger of returning to the former unsanitary conditions. 2200 w. U S Cons Repts, No. 1508—Dec. 1, 1902. No. 52082 D.

**Pavements.**

Pavements Injured by Water. J. W. Howard. Claims that all kinds of pavements are more or less injured and gives a record of experiments to show that the solubility test is needed in all specifications. 2500 w. Munic Jour & Engr—Dec., 1902. No. 52148 C.

What Are Paving, Repaving and Repair? Charles Carroll Brown. A discussion of this question giving legal decisions of several states. 2400 w. Munic Engng—Dec., 1902. No. 52084 C.

**Refuse Destructors.**

The "Fuel" Value of Town Refuse. Ed. C. de Segundo. An article arguing that refuse destructors must be regarded primarily as sanitary appliances, although, within limits, their heat may be usefully applied. 3500 w. Page's Mag—Dec., 1902. No. 52556 B.

**Sewage Purification.**

Sewage Purification by Septic Tanks. M. J. McGuigan. Gives an illustrated description of the successful septic tanks at Vancouver, B. C., their construction and operation. 1200 w. Munic Jour & Engr—Dec., 1902. No. 52147 C.

The Mechanical Purification of Sewage (Ueber Anstalten zur Mechanischen Reinigung der Abwasser). Dr. Th. Weyl. Describing especially the installation of the Mairich system at Ohrdruf near Gotha. 2000 w. 1 plate. Gesundheits-Ingenieure —Nov. 15, 1902. No. 52474 B.

The Proper Operation of Sewage Purification Plants. John W. Alvord. Abstract of a paper prepared for the meeting of the Am. Soc. of Munic. Imp. On the proper regulation of Septic tanks, contact beds, etc., with notes on plants built by the author. 3500 w. Eng News—Nov. 27, 1902. No. 52037.

The Stability of Effluents of Sewage Filters of Coarse Materials. H. W. Clark. Slightly condensed from a paper in the 1901 report of the State Board of Health of Massachusetts, giving results of experiments on bacterial action. 3500 w. Eng Rec—Dec. 27, 1902. No. 52580.

**Sewers.**

Difficult Sewer Construction at Newton, Mass. Brief illustrated description of difficulties met and overcome in the recent extension through Hemlock Gorge, due to the physical features. 600 w. Eng Rec—Nov. 29, 1902. No. 52121.

Suggested Improvement of the Sewer System of Chicago. Extracts from an address by George W. Jackson relating to the present condition and proposed improvements. 1200 w. Eng News—Dec. 11, 1902. No. 52350.

**Snow.**

The Removal of Snow in New York City. An explanation of the form of contract by which the snow is to be removed this winter, which differs greatly from any previous contract; discusses the advantages of the system. 2000 w. Eng Rec —Dec. 13, 1902. No. 52348.

**Street Cleaning.**

A Street Sprinkling and Sweeping Machine (Balayeuse-Arroseuse-Ramasseuse). An illustrated description of a machine for sprinkling, sweeping, and collecting refuse at one continuous operation. 1200 w. Génie Civil—Dec. 6, 1902. No. 52425 D.

**Subway.**

The Aberdeen Cable Subway and Outfall Sewer. G. R. G. Conway. An illustrated description of an electric cable subway which men can walk in, constructed on top of a large sewer. 3500 w. Feilden's Mag—Dec., 1902. No. 52558 B.

**Trackway.**

An Experimental Steel Trackway in New York City. Describes a steel trackway being laid in Murray St., New York city, which is expected to furnish valuable and interesting information regarding steel trackways in city streets. 800 w. Eng News—Dec. 4, 1902. No. 52167.

Rail Tracks for Highway Traffic. Abstract of a paper by Herr A. Nessenius, translated from the *Organ für die Fortschritte des Eisenbahnwesens.* A study of the efforts and experiences of German engineers in the construction of an economical and serviceable iron track for highway purposes. 3000 w. Eng Rec—Dec. 13, 1902. No. 52347.

## WATER SUPPLY.

**Aqueduct.**

The Aqueduct of the Avre (L'Aqueduc de l'Avre). M. Bret. A description of the completed reservoir of Saint Cloud and the aqueduct which brings the water of the Avre and the Vigne to Paris. 10,000 w. 2 plates. Ann des Ponts et Chausées —2 Trimestre, 1902. No. 52448 E+F.

**Artesian Supply.**

The Artesian Water Supply of Memphis, Tenn. Describes the present supply derived from the water-bearing sand underlying the Mississippi Valley about 350 ft. below the surface, with interesting matter from two recent reports. 3200 w. Eng Rec—Nov. 29, 1902. No. 52120.

**Butte, Montana.**

The New Works and Water Supply of the Butte Water Company. Charles W. Paine. Illustrated description of new works consisting of a pipe line 27.2 miles in length, three reservoirs, and two pumping stations. 4300 w. Jour Assn of Engng Socs—Oct., 1902. No. 52275 C.

**High-Pressure Plant.**

High Pressure Pumping Plant and Force Main for the Water-Works of Prescott, Ariz. W. W. Follett. An illustrated description of a pumping plant and pipe line for 500,000 gallons per day. 2800 w. Eng News—Dec. 18, 1902. No. 52511.

**Irrigation.**

An Hawaiian Sugar Plantation. Charles W. Goodale. Describes extensive irrigating operations. 1800 w. Jour Assn of Engng Socs—Oct., 1902. No. 52276 C.

**London.**

The New Augmented Water Supply and Reservoirs for London. A fully illustrated article describing these works. 1500 w. Sci Am Sup—Dec. 13, 1902. No. 52328.

**Ozone.**

The Siemens Ozone Purifying Plants at Wiesbaden, Schierstein and Paderborn (Siemenssche Ozonwasserwerke, Wiesbaden-Schierstein und Paderborn). Dr. G. Erlwein. Detailed illustrations of these extensive plants, sterilizing 250 cubic metres of water per hour by means of ozone. 2000 w. Zeitschr f Elektrochemie—Nov. 27, 1902. No. 52473 G.

**Paris.**

The Water Supply of Paris (L'Alimentation de Paris en Eau). M. Bret. A review of the present supply with maps showing the distribution. 3500 w. 1 plate. Ann des Ponts et Chaussées—2 Trimestre, 1902. No. 52451 E+F.

**Pipe Corrosion.**

See Street and Electric Railways, Stray Currents.

**River Pollution.**

Pollution and Self-Purification of the River Severn at Shrewsbury. A review by George C. Whipple of a report issued by the Royal Commission on Sewage Disposal. 1500 w. Eng Rec—Nov. 29, 1902. No. 52118.

**Stand-pipe.**

A Wrecked Wooden Water Tank and a New Steel Stand-pipe at Madison, Neb. Arnold C. Koenig. An account of a failure of an elevated water tank and details of construction of a new stand-pipe. 900 w. Eng News—Dec. 18, 1902. No. 52514.

**Submerged Mains.**

Submerged Steel Pipes for the Jersey City Water-Works. An illustrated description of the pipes and methods of laying. 2800 w. Eng Rec—Dec. 13, 1902. No. 52346.

**Water Softener.**

Water-Softener of the Maschinenfabrik Grevenbroich. Illustrated description of an apparatus exhibited at Düsseldorf, which is popular in Germany and employed in many large works. 1400 w. Engng—Nov. 21, 1902. No. 52072 A.

# ELECTRICAL ENGINEERING

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## COMMUNICATION.

**Automatic Exchange.**

The Automatic Telephone Exchange. Joseph B. Baker. Some facts relating to the service rendered and the advantages of this system. 1700 w. Elec Rev, N Y—Dec. 13, 1902. No. 52331.

**Cables.**

Imperial Telegraphic Communication. Charles Bright. An address before the London Chamber of Commerce on the British Pacific cable in particular, and on the submarine cable system of the British Empire in general. Serial. Part I. 3500 w. Elec Rev, Lond—Dec. 12, 1902. No. 52547 A.

Telephone Cables. Arthur V. Abbott. This first article discusses the principles of circuit design. Ill. 3700 w. Elec Wld & Engr—Dec. 6, 1902. Serial. 1st part. No. 52263.

The Vera Cruz-Frontera-Campechi Cable for the Mexican Government. Illustrates and describes the making and laying of this cable. 3000 w. Elec Rev, N Y—Dec. 13, 1902. No. 52333.

**Cable Testing.**

See Electrical Engineering, Measurement.

**Coherer.**

The Castelli Coherer. An illustrated review and history of this coherer, in which one or more drops of mercury are placed between iron or carbon electrodes. 1500 w. Elec Rev, Lond—Dec. 12, 1902. No. 52543 A.

**Exchanges.**

Memphis Telephone Company's Exchange System. Illustrated description. 1500 w. Elec Rev, N Y—Dec. 6, 1902. No. 52215.

The Latest Telephone Exchange on Manhattan Island. Illustrated description of the "Morningside" exchange in upper New York. 700 w. Elec Wld & Engr—Dec. 6, 1902. No. 52264.

The New Telephone Exchanges of the Post Office. Illustrated description of two new exchanges of the London Post Office telephone service which have been opened recently on the common battery system. 1000 w. Elect'n, Lond—Nov. 21, 1902. No. 52063 A.

**Independent Telephony.**

Greater Permanent Progress of the Independent Telephone Industry. Fred De Land. Comments on cheap rates and the cost of maintenance. 2700 w. Elec Rev, N Y—Dec. 6, 1902. No. 52213.

Independent Telephony in Buffalo. James Malcolm. Illustrated description of the plant under construction and the system. 1500 w. Elec Wld & Engr—Dec. 13, 1902. No. 52502.

**Lightning.**

Improved Lightning Protection for Telephone Lines (Ueber Neue Blitzschutzeinrichtungen für Fernsprechleitungen). Dr. Adolf Franke. Describing an improved form of lightning arrester with carbon points in vacuum. 4000 w. Elektrotech Zeitschr—Nov. 27, 1902. No. 52465 B.

**Light Telephony.**

Ruhmer's Photoelectric Telephone. A. Frederick Collins. An illustrated article giving an account of Ernst Ruhmer's experiments on the Wannsee, near Berlin, in which a beam of light from an electric arc in a parabolic reflector was sent 7 kilometers to a selenium cell in another reflector. 2000 w. Elec Wld & Engr—Dec. 20, 1902. No. 52519.

**Pupin System.**

Experiments on the Application of Pupin's System to Telephone Circuits. F. Dolezalek and A. Ebeling. An illustrated article translated from the *Elektrotechnische Zeitschrift*, giving an account of experiments carried out by the Siemens & Halske Co. in Germany, on underground cables and overhead telephone lines with Pupin induction coils. Serial. Part I. 2000 w. Elec Rev, Lond—Dec. 12, 1902. No. 52544 A.

Experiments upon the Pupin Long-Distance Telephone System (Untersuchungen über Telephonische Fernleitungen Pupinschen Systems). F. Dolezalek and A. Ebeling. A full account of the tests of the Pupin system made to determine its commercial value for the firm of Siemens & Halske. 5000 w. Elektrotech Zeitschr—Dec. 4, 1902. No. 52468 B.

**Space Telegraphy.**

Wireless Telegraphy in France. E. Guarini. An illustrated review of the work in this field. 1200 w. Elec Rev, Lond—Nov. 28, 1902. Serial. 1st part. No. 52183 A.

**Space Telephony.**

Wireless Telephony by the Collins System. A. Frederick Collins. Reviews work in this field and gives an illustrated description of the writer's system, and an account of what he has accomplished. 2500 w. Elec Rev, N Y—Nov. 29, 1902. No. 52107.

**Telephone Call.**

Telephone Call Operating by Reversal of Current (Rappel Téléphonique par Inversion de Courant). L. Martin. Describing a system in which any one of three telephones on a circuit may call one of the others without affecting the third. 1200 w. Revue Technique—Nov. 25, 1902. No. 52429 D.

**Telephone Rates.**

The Sliding Scale of Rates for the Telephone Company. Henry S. Herr. A paper before the Interstate Independent Telephone Association, showing the necessity for increasing rates as the number of subscribers connected to an exchange increases. 1600 w. Elec Rev, N Y—Dec. 20, 1902. No. 52525.

**Telephony.**

Telephone Situation in the Twin Cities. Huntley L. Howard. An illustrated article giving the history of the telephone business in Minneapolis and St. Paul, describing the plant. 5800 w. Telephony—Dec., 1902. No. 52216.

The Telephone Situation of To-day. A. E. Dobbs. Statistics showing the rapid growth of the independent telephone business, and the lessons learned. 2300 w. Elec Rev, N Y—Dec. 13, 1902. No. 52330.

**Transmitter.**

The Pasquet Telephone Transmitter (Transmetteurs Téléphoniques, Système Louis Pasquet). J. A. Montpellier. Describing the improved form of microphone transmitter used in the French government lines. 1500 w. L'Electricien—Nov. 22, 1902. No. 52478 B.

The Telephone Transmitter, Its Early History, Its Present Status with Relation to the Berliner Patent—Past and Present. J. J. Nate. Abstract of paper before the Interstate Independent Telephone Association, giving a history of telephone invention. 1200 w. Elec Rev, N Y—Dec. 20, 1902. No. 52526.

## DISTRIBUTION.

**Accumulators.**

See Electrical Engineering, Electro-Chemistry.

**Converters.**

Experiments on Synchronous Converters. W. M. Thornton. Read before the Newcastle Local Section of the Inst. of Elec. Engrs. The object of the experiments was to find how the efficiency varied with load for all conditions of excitation; to find any discrepancies between the theoretical and observed losses; and to locate the causes which would give rise to them.

4200 w. Elec Engr, Lond—Dec. 5, 1902. No. 52380 A.

**Fuses.**

The Permanency of Safety Fuses (Ueber Unwerwechselbarkeit bei Schmelzsicherungen). R. Hundhausen. A review of various forms of fuse construction, with data concerning their permanency. 5000 w. Elektrotech Zeitschr—Dec. 4, 1902. No. 52469 B.

**Karlsruhe.**

The Light and Power Plant of the Port of Karlsruhe on the Rhine (Die Licht und Kraftanlagen des Rheinhafens zu Karlsruhe). F. Winawer & C. Bender. A detailed account of the transformer station and electric distribution; also electric cranes, hoists, and conveyers; together with lighting plant. The current is obtained from the municipal plant. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 29, 1902. No. 52406 D.

**Sub-Stations.**

The Electrical Equipment of Sub-Stations. E. Parry and W. Casson. An illustrated description of the arrangements and apparatus in sub-stations of electric distribution systems, as designed by H. F. Parshall, with plans and diagrams. 6500 w. Trac and Trans—Dec., 1902. No. 52561 E.

**Subway.**

See Civil Engineering, Municipal.

**Transformation.**

Six-Phase Transformation. A. S. McAllister. Explains the transformation from two or three phases to six phases by means of rotary converters. Diagrams. 900 w. Am Elect'n—Dec., 1902. No. 52247.

## ELECTRO-CHEMISTRY.

**Accumulators.**

How to Determine the Best Conditions in Storage Battery Practice. Carl Hering. A discussion of the most economical commercial operation of accumulators, considering both first cost and operating expenses. 3000 w. Elec-Chem Ind—Dec., 1902. No. 52588 C.

The Storage Battery as an Electrolytic Cell. C. J. Reed. A general review of the principles of electrolytic action and the relation between storage batteries and other electrolytic cells. 3500 w. Elec-Chem Ind—Dec., 1902. No. 52590 C.

**Ampere Company.**

The Ampere Electro-Chemical Company. An account of an experimental company, with a laboratory at Niagara Falls, whose object is to originate and develop new electro-chemical processes to the point of commercial application. 900 w. Ir Age—Dec. 18, 1902. No. 52535.

**Calcium and Strontium.**

The Production of Calcium and Strontium. H. Danneel. An illustrated description of an electric furnace and process used at the Institute for electro-metallurgy at Aachen, Germany, by which pure calcium and strontium are obtained from their chlorides. 1000 w. Elec Wld & Engr—Dec. 20, 1902. No. 52523.

**Calcium Carbide.**

Calcium Carbide and Acetylene. A general review of these industries, with illustration and curves. 1400 w. Elec-Chem Ind—Dec., 1902. No. 52589 C.

**Copper.**

Electrolytic Refining of Copper. An illustrated description of the method, translated from *La Nature*. 1200 w. Sci Am Sup—Dec. 6, 1902. No. 52221.

**Electric Furnaces.**

High Temperature Electro-chemistry. R. S. Hutton and J. E. Petavel. Abstract of a paper before the Manchester Local Section of the Institution of Electrical Engineers, illustrating and describing experimental and technical electrical furnaces, particularly those in the electrochemical laboratory of Owens College. Manchester, Eng. Serial. Part I. 1500 w. Elect'n, Lond—Dec. 12, 1902. No. 52531 A.

Recent Electrochemical Developments. Clinton Paul Townsend. An illustrated description of electric furnace structures, of the "tube" type, invented by H. N. Potter. 800 w. Elec Wld & Engr—Dec. 20, 1902. No. 52524.

**Electrodes.**

Bipolar Electrodes (sur les Electrodes Bipolaires). MM. Brochet & Barillet. A discussion of the effect of a metallic mass placed in an electrolyte and not connected with either electrode. 1500 w. Comptes Rendus—Nov. 17, 1902. No. 52440 D.

**Electrolysis.**

General Characteristics of Electrolysis. Harry S. Coyle. Discusses mainly its usefulness in the sciences and arts and its laws. 2200 w. Telephony—Dec., 1902. No. 52217.

**Lithography.**

Electrochemistry in Lithography. E. C. Handy. A brief account of a new process which greatly reduces the cost of this class of work. 900 w. Elec Wld & Engr—Dec. 13, 1902. No. 52504.

**Nickel Cell.**

Self-Forming Separator in a Nickel Peroxide Storage Cell. A. L. Marsh. Describes the construction of this cell, which is said to have considerable advantage over the dry cells in present use. 900 w. Elec Wld & Engr—Dec. 13, 1902. No. 52503.

**Ozone.**

See Civil Engineering, Water Supply.

**Polarization.**

Electrochemical Oscillations. Woolsey McA. Johnson. An account of some interesting observations on what may be termed electrolytic memory. 800 w. Elec Wld & Engr—Dec. 13, 1902. No. 52505.

**Sodium Chloride.**

Sodium Chloride in Electrolytic Caustic Alkali. Clinton Paul Townsend. A paper considering the movement of undecomposed sodium chloride into the caustic compartment of an electrolytic cell, with curves. 1800 w. Elec-Chem Ind—Dec., 1902. No. 52587 C.

**Steel.**

Manufacture of Steel by the Electric Furnace. Translation, with additions by P. McN. Binnie, of a paper by Charles Bertolus, of St. Etienne, France. Describes the operation of the Keller process at Kerrousse, near Hennebont, giving cost and quality obtained. 4800 w. Ir Age—Dec. 11, 1902. No. 52259.

## ELECTRO-PHYSICS.

**Electron Theory.**

On Electrons. Sir Oliver Lodge. Paper before the Institution of Electrical Engineers, giving full account of the latest theory of electricity and magnetism. Also editorial comment. Serial. Part I. 4000 w. Elect'n, Lond—Dec. 12, 1902. No. 52532 A.

On Electrons. Abstract of an address by Sir Oliver Lodge, explaining the present state of knowledge of electrical theories. 5300 w. Engng—Dec. 5, 1902. No. 52365 A.

**Laboratory.**

The Electrotechnical Laboratory of the Municipal Electric Works of Munich (Das Elektrotechnische Laboratorium der Städtischen Elektricitätswerke in München). F. Uppenborn. With plan of the building and views of the various rooms and apparatus. 3500 w. Elektrotech Zeitschr—Nov. 27, 1902. No. 52463 B.

**Magnetism.**

A Theory of Magnetism. Johannes Zacharias. An attempt to prove that the magnetic force is a phenomenon due to pressure. 1800 w. Elec Wld & Engr—Dec. 20, 1902. No. 52522.

**Photo-Electric Effects.**

Photo-Electric Experiments. A. Frederick Collins. Illustrated description of experiments in photo-electric action. 1700 w. Sci Am Sup—Dec. 20, 1902. No. 52398.

**Radiography.**

The Determination of the Velocity of X Rays (Observations et Expériences Complémentaires Relatives à la Determination de la Vitesse des Rayons X). R. Blondlot. A continuation of the author's experiments upon the velocity of X rays, together with a discussion of their nature. 1200 w. Comptes Rendus—Nov. 10, 1902. No. 52437 D.

Velocity of Propagation of X-Rays. R. Blondlot. Translated from the *Comptes Rendus*. An account of researches and experiments giving results. 2500 w. Elect'n, Lond—Nov. 21, 1902. No. 52065 A.

## GENERATING STATIONS.

**Accumulators.**

See Electrical Engineering, Electrochemistry.

**Chicago, Edison.**

The Randolph Street Sub-station and the Development of the Chicago Edison System. A description of some recent features introduced showing important changes that are taking place in the character of this company's distribution. 3800 w. Elec Wld & Engr—Nov. 29, 1902. No. 52109.

**Cleckheaton.**

Cleckheaton Electricity Works. An illustrated description of a combined electric generating station and refuse destructor in Yorkshire. 1600 w. Elec Rev, Lond—Dec. 12, 1902. No. 52546 A.

Cleckheaton Electricity Works. Illustrated detailed description of works for the supply of light and power, and a refuse destructor from which it is hoped to get much of the steam required. 1800 w. Elec Engr, Lond—Nov. 28, 1902. No. 52178 A.

**Commutation.**

Commutation. H. St. Hill Mawdsley. Briefly considers methods for improving commutation. Ill. 1000 w. Elec Rev, Lond—Dec. 5, 1902. No. 52382 A.

**Converters.**

See Electrical Engineering, Distribution.

**Dynamos.**

The Care of Dynamos and Motors. F. J. A. Matthews. Discusses the care needed, points requiring special attention, etc. 3000 w. Mech Engr—Nov. 22, 1902. No. 52061 A.

The Computations for Continuous-Current Dynamos (Zur Berechnung der Gleichstrommaschine). Emil Korrodi. Discussing a method of determining graphically the proportions of the various parts and arranging them in tabulated form for a series of sizes. 1800 w. Elektrotech Zeitschr—Nov. 27, 1902. No. 52464 B.

The Use of Specific Forms in Designing Dynamo Machinery, and the Design of a Rotary Converter. H. M. Hobart. Describes a series of forms prepared for use in designing continuous-current commutating machinery. 800 w. Elec Rev, Lond—Dec. 5, 1902. Serial. 1st part. No. 52381 A.

**Gas Engines.**

See Mechanical Engineering, Special Motors.

**Generating Sets.**

A Modern Slow-Speed Steam Alternator. An illustrated account of a standard steam-generator of a London firm, which has recently been set to work, with a statement of the performance. 1400 w. Ir & Coal Trds Rev—Dec. 5, 1902. No. 52360 A.

On the Governing of Engines for Alternating Current-Supply. G. R. J. Parkinson. Remarks applying more particularly to the method of connecting alternators directly to a medium-speed engine. 1000 w. Elec Rev, Lond—Dec. 5, 1902. No. 52383 A.

The Wheel Capacity for Engine-Driven Alternators. H. F. Schmidt. Discusses the steam engine side of the question and certain electrical requirements, with a suggestion. 1500 w. St Ry Jour—Dec. 13, 1902. No. 52309 D.

**Hydro-Electric Plants.**

A Water-Power Plant with a Head of 3,116 ft. at Vouvry, Switzerland. From *Le Genie Civil.* Illustrated description of a plant that will supply electricity for lighting and power to a large number of Swiss towns and villages in the valley of the Rhone. 1000 w. Eng News—Nov. 27, 1902. No. 52028.

The Hydraulic Power Station at Champ (Usine Hydro-Electrique de Champ, Isère). A. Dumas. An illustrated account of the electric station at Champ on the River Drac, near Grenoble, for the development of 7,200 horse power and its electrical distribution. 3000 w. 1 plate. Génie Civil—Nov. 22, 1902. No. 52424 D.

The New Plant of the Canadian Niagara Falls Company. Orrin E. Dunlap. An illustrated report of the progress of the work of the Canadian Niagara Power Co. 1100 w. Sci Am—Dec. 6, 1902. No. 52218.

The Vouvry Water-Power Development of 3,117 Foot Head. From *Le Genie Civil.* An illustrated description of a plant which possesses the highest head of all water power developments yet attempted. 2000 w. Eng Rec—Nov. 29, 1902. No. 52122.

Transmission Plant of the Otonabee Power Company. An illustrated description of a recent Canadian installation. 1900 w. Can Elec News—Dec., 1902. No. 52298.

Water-Power in Electrical Supply. Alton D. Adams. A discussion of several hydro-electric plants in actual operation, with a record of variations in water supply and energy output, showing, on the whole, an economy in the use of water-power. Curves. 2800 w. Cassier's Mag—Dec., 1902. No. 52550 B.

**Isolated Plants.**

Economy in Design and Operation of Isolated Electric Plants. P. R. Moses. A discussion of the use of auxiliary apparatus in isolated plants, showing the resulting reductions in working costs. 3000 w. Engineering Magazine—January, 1903. No. 52490 B.

**Municipal Plants.**

Equipment and Operation of Municipal Electric Light Plants in Massachusetts. Alton D. Adams. Notes the progress since the first municipal plant in 1889. 1000 w. Munic Engng—Dec., 1902. No. 52086 C.

**Nuneaton.**

Nuneaton Electricity Works. An illustrated account of the electric station and distribution system at Nuneaton, Warwickshire, and curves of costs and accounts. 2500 w. Elec Engr, Lond—Dec. 12, 1902. No. 52533 A.

**Parallel Driving.**

The Parallel Driving of Alternators. (Ueber den Parallelbetrieb von Wechselstrommaschinen). H. Görges. A review of the previous paper of Rosenberg, discussing the synchronizing action of two alternators coupled in parallel. 2500 w. Elektrotech Zeitschr—Dec. 4, 1902. No. 52466 B.

**Power House.**

See Street and Electric Railways.

**Reconstruction.**

The Economy of Reconstructing Central Stations to Modern Methods. C. R. Maunsell. Outlines an old and a modern plant showing the gain on investment by modern methods. 1500 w. Am Gas Lgt Jour—Dec. 15, 1902. No. 52390.

**Sub-Stations.**

See Electrical Engineering, Distribution.

**Standards.**

Standards for Electrical Machinery and Transformers (Normalien für Elektrische Maschinen und Transformatoren). A revision of the standards of the *Verband Deutscher Elektrotechniker* as set forth in 1901, and discussed at the recent convention at Düsseldorf in June, 1902. 4000 w. Zeitschr d Ver Deutscher Ing—Dec. 13, 1902. No. 52414 D.

**Superintendents.**

The Qualifications of a Central Station Superintendent. Considers the desirable characteristics as a man and the professional attainments he should possess. 3900 w. Cent Sta—Dec., 1902. No. 52237.

## LIGHTING.

**Illumination.**

Display Lighting. Signs and Decorations. Russell Spaulding. Suggestions helpful in producing good effects in this work. 1600 w. Cent Sta—Dec., 1902. No. 52236.

Distributed Lighting. Douglass Burnett. On means for measuring the illumination of surfaces. A study of the distribution and diffusion of light. 2000 w. Trans Am Inst of Elec Engrs—Nov., 1902. No. 52291 D.

Some Notes on Illumination. Bassett Jones, Jr. An article discussing various methods of lighting required under certain specific conditions. 1500 w. Elec Wld & Engr—Dec. 20, 1902. No. 52520.

**Photometry.**

Discussion of Papers on Photometry and Illumination. 11300 w. Trans Am Inst of Elec Engrs—Nov., 1902. No. 52-294 D.

Integrating Photometer for Glow Lamps and Sources of Like Intensity. Charles P. Matthews. Illustrates and describes an apparatus for the photometric study of incandescent lamps and other sources of the same order of brightness. 3300 w. Trans Am Inst of Elec Engrs—Nov., 1902. No. 52290 D.

Some Methods of Photometry as Applied to Incandescent Lamps. J. T. Marshall. Describes the invention and use of the sliding scale photometer. 1800 w. Trans Am Inst of Elec Engrs—Nov, 1902. No. 52292 D.

The Commercial Accuracy of Photometrical Measurements. Clayton H. Sharp. Discusses whether photometrical measurements conform in general to the requirements of commercial accuracy. 2500 w. Trans Am Inst of Elec Engrs—Nov., 1902. No. 52293 D.

**Train Lighting.**

A French System of Train Lighting. P. Letheule. A description, with diagrams of the M. F. Loppe system of electric lighting for trains, in which the dynamo has two field windings in opposition, so that the voltage is regulated closely. A storage battery is also used. 2000 w. Elec Wld & Engr—Dec. 20, 1902. No. 52521.

## MEASUREMENT.

**Cable Testing.**

Plant for Testing Cables at High Pressures. Stuart A. Russell. A description of a plant installed by the India Rubber, Gutta Percha and Telegraph Works Co. of Silvertown, Eng., for testing submarine cable core at a pressure of 5000 volts. Diagrams. 1200 w. Engr, Lond (Elec Engng Sup)—Dec. 12, 1902. No. 52542 A.

**Efficiency.**

A Method of Determining the Efficiency of Dynamos. J. R. Ashworth. On the use of retardation curves for efficiency determinations. 2000 w. Elec Rev, Lond—Nov. 28, 1902. No. 52179 A.

**Graduations.**

The Graduations of Electrical Measuring Apparatus (Sulla Graduazione degli Apparecchi Elettrici di Misura). V. Arcioni. Discussing graphical methods for laying out the scales of instrumental graduations so as to insure approximate uniformity. 1200 w. L'Elettricita—Nov. 30, 1902. No. 52482 B.

**Indicator.**

A Recording Indicator for Maximum Currents and Shortcircuits (Ein Registrirender Maximalstrom und Kurzschlussanzeiger). H. Marken. A solenoid opposed by a spring is connected with a recording mechanism and revolving disc. 1800 w. Elektrotech Zeitschr—Dec. 11, 1902. No. 52472 B.

**Insulation.**

The Measurement of Defects in Insulation in Multiple Conductors (Die Messung von Isolationsfehlern bei Mehrleiteranlagen). E. Müllendorff. Deriving equations by use of which the leakage may be determined according to its distribution from successive measurements. 1200 w. Elektrotech Zeitschr—Dec. 11, 1902. No. 52471 B.

**Meter Testing.**

Testing Electric Meters in Place (Verification sur Place des Compteurs d'Energie Electrique). M. Aliamet. Giving methods of testing the Aron meter, with practical examples. Three articles, 3500 w. L'Electricien—Nov. 29, Dec. 6, 13, 1902. No. 52479 each B.

**Photometry.**

See Electrical Engineering, Lighting.

**Thermal Instruments.**

The Olivette Thermal Instruments (Appareils Thermiques de la Maison Olivette). A. Bainville. Describing voltmeters and ampere meters which operate by the heating and expansion of platinum wire. 1000 w. L'Electricien—Nov. 29, 1902. No. 52480 B.

**Three-Phase.**

The Measurement of Three Phase Currents by a Single Wattmeter (Mesure à l'Aide d'un Seul Wattmètre de la Puissance dan les Circuits Equilibrés, parcourus par des Courants Triphases). O. Robert. The method involves the connection of the two wires of the instrument successively with the three circuit wires. 1200 w. Revue Technique—Dec. 10, 1902. No. 52433 D.

Three-Phase Measurements. A. S. McAllister. Analyzes a case of current unbalance in a three-phase system, showing how inaccurate may be the results of formulae which apply to wattmeter measurements when dealing with balanced circuit. 1200 w. Elec Wld & Engr—Dec. 13, 1902. No. 52506.

## POWER APPLICATIONS.

**Differential Compounding.**

The Differentially-Compounded Motor. W. R. Kelsey. A discussion of the design of differential-compound field windings for electric motors where close speed regulation is necessary; with curves. 1000 w. Elec Engr, Lond—Dec. 12, 1902. No. 52534 A.

**Machine Tools.**

Electric Power Required by Various Tools and General Construction Methods Abroad. Notes some of the methods of construction, data of power used, and general equipment of foreign plants having modern equipments, and the methods of control of the alternating-current motors. 3500 w. Mod Mach—Dec., 1902. No. 52140.

**Mining.**

Electric Power for General Purposes in Mining and Milling. John B. Tregloan. Read before the California Miners' Assn. Deals with results obtained in Amador Co., Cal., using electricity at $6.50 per h. p. per month. 2800 w. Min & Sci Pr—Nov. 29, 1902. No. 52210.

The Use of Electricity in Modern Mining Installations. Frank C. Perkins. Information regarding modern electric installations, both of direct and alternating current. Ill. 1400 w. Min Rept—Nov. 27, 1902. Serial. 1st part. No. 52099.

**Railway Shops.**

Electricity in Railroad Shops. L. R. Pomeroy. A discussion of the power question and the advantages of the electric drive, the losses, etc., with suggestions. General discussion follows. 8500 w. Cent Ry Club—Nov., 1902. No. 52336 C.

**Speed Control.**

A Variable Reluctance Method of Motor Speed Control. G. Frederick Packard. Describes the special construction patented by Frederick A. Johnson for providing speed control over a very wide range in motors. Discusses also the regulators patented by Thomas A. Edison and by Philip Diehl. Ill. 3500 w. Trans Am Inst of Elec Engrs—Nov., 1902. No. 52295 D.

Oerlikon Polyphase Motor with Four Speeds (Drehstrommotor der Maschinen fabrik Oerlikon mit Vier Geschwindigkeitsstufen). Dr. H. Behn-Eschenburg. A description of an improved polyphase for speeds of 500, 750, 1,000 and 1,500 revolutions per minute; also of a continuous-current motor for 350 to 1,600 revolutions. 3500 w. Elektrotech Zeitschr—Dec. 4, 1902. No. 52467 B.

The Speed Regulation of Induction Motors (Die Tourenregulirung von Induktionsmotoren). M. Osnos. An examination of the efficiency at various speeds for different styles of induction motors. 6000 w. Elektrotech Zeitschr—Dec. 11, 1902. No. 52470 B.

Three-Phase Motors with Wide Range of Speed Variation. Dr. H. Behn-Eschenburg. Illustrates and describes the new drum windings introduced by the Oerlikon Co., stating the advantages gained. 2800 w. Elect'n, Lond—Nov. 21, 1902. No. 52064 A.

**Steel Works.**

Electrically Operated Charging Machines, Hoists, Hauling and Conveying Apparatus in Iron and Steel Works. Frank C. Perkins. Illustrated description of various forms of apparatus in which electric motive power is employed. 3300 w. Sci Am Sup—Dec. 20, 1902. No. 52396.

**Steering Gear.**

See Marine Engineering.

## TRANSMISSION.

**California.**

The Northern California Power Company's Transmission. An illustrated detailed description of the system of this company for furnishing light and power. 3800 w. Jour of Elec—Dec., 1902. No. 52274 C.

**Switzerland.**

A European 30,000-Volt Three-Phase Power Transmission. Illustrated description of the high-tension plant between Hochfelden and Oerlikon. 2500 w. Elect'n, Lond—Dec. 5, 1902. No. 52384 A.

See also Electrical Engineering, Generating Station.

## MISCELLANY.

**Address.**

Some Limits in Heavy Electrical Engineering. James Swinburne. Presidential address to the Inst. of Elec. Engrs., London. Confined to a discussion of heavy electrical engineering. 4000 w. Elect'n, Lond—Dec. 5, 1902. Serial. 1st part. No. 52385 A.

**Development.**

A Study of Electrical Developments. Valentine Ryan. The present article is a review of the general conditions of the electrical industry, calling attention to some things yet to be accomplished. 2200 w. Elec Rev, Lond—Nov. 21, 1902. Serial. 1st part. No. 52066 A.

# GAS WORKS ENGINEERING

**Calcium Carbide.**

See Electrical Engineering, Electrochemistry.

**Coal Storing.**

Coal-Storing Plant at the Ipswich Gas-Works. An illustrated description of a complete and somewhat unique plant, comprising the unloading, weighing and conveyance to the coal stores. 1200 w. Jour Gas Lgt—Dec. 2, 1902. No. 52376 A.

**Conveying.**

Coal Unloading and Conveying Plant at the Nancy Gas Works. An illustrated description, from the *Journal für Gasbeleuchtung* of the arrangements at this town in France. 800 w. Jour Gas Lgt—Nov. 18, 1902. No. 52057 A.

**Distribution.**

Distribution Practice in the United States. Describes as well as possible what is considered good distribution practice in the gas industry. Ill. 6000 w. Jour Gas Lgt—Nov. 25, 1902. No. 52173 A.

**Efficiency.**

Efficiency in Gas Manufacture. S. Tagg. Read before the Manchester and District Jour. Gas Assn. A discussion of methods best adapted to secure economy in gas making and the principles that should guide gas engineers. 5600 w. Jour Gas Lgt—Dec. 2, 1902. No. 52377 A.

**Explosions.**

Experiments on Gas Explosions in a Closed Vessel. L. Bairstow and E. C. Horsley. An account of experimental investigations with results. 900 w. Engng—Nov. 28, 1902. No. 52192 A.

**Gas Engines.**

See Mech. Engineering, Special Motors.

**Mantles.**

Microscopical Examination of Incandescent Mantles. Dr. C. Killing. Translated from the *Jour für Gasbeleuchtung*. An illustrated account of investigations. 2300 w. Pro Age—Dec. 15, 1902. No. 52340.

**Mond Gas.**

Mond Gas Plant at Farnley. Illustrates and describes the plant of the Farnley Iron Co., Ltd., near Leeds, which will produce gas equivalent to 20,000 h. p., were it all to be used in engines. 2000 w. Nov. 21, 1902. No. 52079 A.

**Natural Gas.**

Natural Gas in Sussex. A brief account of the discovery of gas at Heathfield, England, the composition and geological formation, and what has been done to test the extent of the field. 1300 w. Gas Wld—Nov. 22, 1902. No. 52054A.

**New Works.**

A Complete New Gas Works for Slough. An illustrated description of an inclined retort system for small works, with explanatory notes. 3500 w. Jour Gas Lgt—Nov. 18, 1902. No. 52056 A.

**Photometry.**

See Electrical Engineering, Lighting.

**Pipe Corrosion.**

See Street and Electric Railways, Stray Currents.

**Tar.**

Determination of Water in Tar. Herr Becker. Illustrates and describes an apparatus which gives an exact and rapid analysis. 800 w. Gas Wld—Nov. 22, 1902. No. 52055 A.

# INDUSTRIAL ECONOMY

**Accounting.**

Property Returns on Public Works. A. F. Bridgman. An outline of methods adopted by the U. S. and State governments and various commissions in charge of public works, for taking account of stock and making inventories of property. 1200 w. Eng Rec—Dec. 27, 1902. No. 52577.

**Address.**

Sir William Henry Preece's Address before the Society of Arts. Discusses manufactures and commerce aiming to determine the causes which result in successful or disastrous financial undertakings and showing that the commercial conduct of industrial processes follow distinct laws. 7700 w. Jour Soc of Arts—Nov. 21, 1902. No. 52051 A.

The Science of Business. Editorial review of Sir William Henry Preece's address before the Society of Arts. 1800 w. Engng—Nov. 21, 1902. No. 52074 A.

**Cost Keeping.**

Cost Finding for Moderate-Sized Shops. Hugo Diemer. An example of the successful application of the premium system to a shop employing about 400 men in the manufacture of machine tools. 2500 w. Engineering Magazine—January, 1903. No. 52491 B.

**Decadence.**

Decadent Industrial Works. Discusses the subject in relation to individual concerns, and the causes. 1200 w. Ir Age—Dec. 4, 1902. No. 52132.

**Education.**

The Springfield (Mass.) Evening School of Trades. E. R. Markham. An illustrated description of the school and an account of the work done. 2500 w. Am Mach—Dec. 4, 1902. No. 52162.

The Training of Professional Engineers. Prof. John Goodman. A practical discussion of engineering education in both shop and college. 2000 w. Page's Mag—Dec., 1902. No. 52554 B.

**Engineering Co-operation.**

The Engineer of the Twentieth Century. Chas. F. Scott. Address before the Engineers' Club of Philadelphia, urging the closer co-operation of the American engineering societies and the erection of an engineering societies' building in New York. 1200 w. Elec Rev, N Y—Dec. 20, 1902. No. 52528.

**Engineering Economics.**

The Engineer as Financier. Dr. Robert H. Thurston. An able review of the financial and economic problems which the engineer is called upon to solve, and of increasing importance in the organization and advancement of civilization and his vast opportunities. 7500 w. Cassier's Mag—Dec., 1902. No. 52551 B.

**Insurance.**

Insurance of Ships at Lloyds. Lawrence Irwell. Brief account of Lloyd's coffee house and other matters bearing upon the insurance of ships. 3200 w. Marine Rev—Dec. 11, 1902. No. 52302.

**Invention Development.**

The Commercial Development of Inventions. James Swinburne. A very entertaining account of the difficulties that beset the average inventor, and a suggestion for a strong financial concern that will develop inventions on terms fair to all parties. 4800 w. Page's Mag—Dec., 1902. No. 52553 B.

**Krupp.**

Notes on the Krupp Works (Eniges über Krupp). A brief review of the development of the Krupp works, with plate of illustrations showing views in the works and plans and elevations of the workmen's houses. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 29, 1902. No. 52459 D.

**Output.**

Limitation of Output by Molders. James A. Murphy. Discusses the restriction of output, and the attitude of the Molders' Union. 1700 w. Ir Trd Rev—Dec. 4, 1902. No. 52157.

**Patents.**

The International Union for the Protection of Industrial Property and the German Empire (Die Internationale Union zum Schutze des Gewerblichen Eigentums und das Deutsche Reich). Dr. F. Damme. A review of the work of the Union, and the effect which it may have upon patent and proprietary legislation in Germany. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 15, 1902. No. 52401 D.

**Piecework.**

Piecework in a Locomotive Erecting Shop. J. Korns. Gives suggestions based upon successful experience. 1000 w. Am Engr & R R Jour—Dec., 1902. No. 52112 C.

**Telephone Rates.**

See Electrical Engineering, Communication.

**Transportation.**

The American Merchant Marine. A review of the present condition, with comparison with former record, and description of notable passenger steamers recently constructed. 2500 w. Sci Am—Dec. 13, 1902. No. 52313.

The Development of Transportation on the Great Lakes. Waldon Fawcett. A review of changes in size and character of vessels, growth in passenger travel, and other interesting statistics. 1400 w. Sci Am—Dec. 13, 1902. No. 52316.

**Transport Systems.**

Connections between Railway and Waterway Systems (Le Raccordement du Réseau Ferré et du Réseau Navigable). Paul Léon. A discussion of transport problems in France showing the advantages of harmonious action between the railways and the canal systems. 2500 w. Génie Civil—Dec. 6, 1902. No. 52426 D.

**Trusts.**

President Roosevelt and "the Trusts." Joseph S. Auerbach. Considers the views of Mr. Roosevelt as expressed in his addresses, and gives a suggestion. 7300 w. N Am Rev—Dec., 1902. No. 52094 D.

The Great Consolidations Called "Trusts." Peter S. Grosscup. A valuable address delivered before the students of the University of Nebraska, at Lincoln. 5500 w. R R Gaz—Dec. 19, 1902. No. 52509.

What Is Publicity? Henry C. Adams. Discusses its general, particular, and administrative significance in relation to the solution of the trust problem. 4000 w. N Am Rev—Dec., 1902. No. 52095 D.

# MARINE AND NAVAL ENGINEERING

**Accidents**

The Accident on H. M. S. "Bullfinch." Summary of evidence given at the inquiry into the breakdown of machinery on the Bullfinch taken from the judgment of Mr. Justice Kennedy. 6000 w. Engng—Nov. 21, 1902. No. 52076 A.

**Boat Cranes.**

The Construction of Boat Cranes (Beitrag zur Konstruktion von Bootskränen). J. Stieghorst. A discussion of the construction of davit cranes on ships for the most convenient lowering and hoisting of boats at sea. Serial. Part I. 2500 w. Schiffbau—Dec. 8, 1902. No. 52462 D.

**Cruiser.**

The Protected Cruiser "Bogatyr" (Der Geschützte Kreuzer "Bogatyr"). A detailed description of the protected cruiser built by the Vulkan Works at Stettin for the Russian government, giving especially details of the propelling machinery, water-tube boilers, etc. 4000 w. 3 plates. Zeitschr d Ver Deutscher Ing—Nov. 22, 1902. No. 52404 D.

**Fire Apparatus.**

Fire Extinguishing Apparatus for Ships. Brief illustrated description of the Clayton fire extinguishing apparatus, which uses sulphur dioxide. 2000 w. Prac Engr—Nov. 28, 1902. No. 52252 A.

**Freighters.**

The Two Great Freighters for the Pacific Trade. Illustrates and describes the interesting features of the 20,000-ton steamships building at New London, Conn., for the Pacific trade. 1400 w. Sci Am—Dec. 13, 1902. No. 52314.

**French Navy.**

New Vessels of the French Navy. Translated from *Illustrirte Zeitung.* Brief illustrated description of a recent battleship, cruiser and torpedo boat destroyer. 1000 w. Sci Am Sup—Dec. 20, 1902. No. 52397.

The French Naval Programme. An editorial review of the proceedings of the French government in regard to naval affairs. 2500 w. Engng—Nov. 28, 1902. No. 52189 A.

**Insurance.**

See Industrial Economy.

**Lighthouse.**

See Civil Engineering, Canals, Rivers and Harbors.

**Liners.**

The Latest of the Fast Transatlantic Liners. Illustrated description of the "Kaiser Wilhelm II." 1200 w. Sci Am—Dec. 13, 1902. No. 52315.

**Naval Officers.**

Naval Officers. An editorial review of the proposed changes in the personnel of the British navy by which executive engineering and marine officers will all receive the same education and training as cadets, and engineers will receive official rank. 2200 w. Engng—Dec. 12, 1902. No. 52565 B.

**Oil Fuel.**

Oil as Fuel in Warships. A review of Admiral Melville's report, with illustrations of burners tested. 3000 w. Engr, Lond—Nov. 21, 1902. No. 52077 A.

See also Mechanical Engineering, Steam Engineering.

**Oil-Tank Steamer.**

New Large Oil-Tank Steamer Captain A. F. Lucas. Illustrated description of an oil-carrying vessel now under construction. 2000 w. Marine Engng—Dec., 1902. No. 52310 C.

Oil-Fuel Installation on Steamship. J. M. Guffey. Illustrated description of a vessel transformed into a tank ship for carrying oil in bulk and for burning oil as fuel. 1500 w. Marine Engng—Dec., 1902. No. 52311 C.

**Portsmouth Yard.**

The Royal Dockyard at Portsmouth. W. Price. An illustrated description of the navy yard at Portsmouth, England, and a criticism of its engineering facilities and administration. 2400 w. Page's Mag—Dec., 1902. No. 52552 B.

**Shipping Combine.**

See Industrial Economy.

**Steering Gear.**

An Electric Steering Gear. An illustrated description of an electrically-controlled steering gear which Siemens Bros. & Co. have fitted on the large steam yacht "Valhalla." 1000 w. Elect'n, Lond—Dec. 12, 1902. No. 52530 A.

Electrical Steering Gear on the "Finland." Illustrated description of the apparatus, designed by M. Pfatischer, which is an application of the principle of the Wheatstone bridge to the control of a ship's rudder. 2200 w. Elec Wld & Engr—Nov. 29, 1902. No. 52108.

**Submarines.**

Official Trials of Our Submarine Boats. Brief account of the gratifying results obtained in the trials of the "Adder" and the "Moccasin," two of the six submarines being constructed for the U. S. Navy. Ill. 900 w. Sci Am—Nov. 29, 1902. No. 52042.

Submarine Boats. Discusses the Holland, Lake, and Moriarty boats. 5000 w. Engng—Dec. 5, 1902. No. 52363 A.

**Testing Tank.**

Experimental Laboratory of the North German Lloyd. Condensed translation of a paper by Herr A. Schromm, in the *Austrian Weekly of Public Works,* describing the station at Bremerhaven. 1000 w. Eng Rec—Nov. 29, 1902. No. 52119.

**Transportation.**

See Industrial Economy.

**Turbine Steamers.**

Forthcoming Developments in the Marine Steam Turbine. Herbert C. Fyfe. A very well illustrated review of war ships, passenger steamers and pleasure yachts equipped with Parson's steam turbines. 5000 w. Page's Mag—Dec., 1902. No. 52-555 B.

The Application of Turbine Propulsion to Passenger Vessels. Especially describes the "Queen Alexandra," with general discussion of the application to vessels. Ill. 1200 w. Sci Am—Dec. 13, 1902. No. 52-319.

**U. S. Navy.**

America's Bid for Naval Supremacy. Archibald S. Hurd. Reviews briefly the history of the American navy, and the causes of the present lack of officers and men to serve all the ships built or in course of construction. 5000 w. Nineteenth Cent—Dec., 1902. No. 52370 D.

The United States Naval Engineering Report. Editorial review of the report of Admiral Melville. 2400 w. Engng—Nov. 21, 1902. No. 52075 A.

**Ventilation.**

The Ventilation of War Ships (Die Lüftung der Schiffsraume bei Kriegsschiffen). Otto Kratschmer. A discussion of the arrangement of ventilating pipes in connection with the maintenance of watertight compartments. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 22, 1902. No. 52405 D.

**Yachts.**

English Turbine-Propelled Yachts. Illustrations with particulars of the three high-speed yachts fitted with the Parsons marine steam turbine. 400 w. Sci Am—Dec. 13, 1902. No. 52318.

The Development of the Auxiliary Yacht. Illustrated description of the "Ariadne," with general remarks on this type of vessel. 1000 w. Sci Am—Dec. 13, 1902. No. 52317.

# MECHANICAL ENGINEERING

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## AUTOMOBILES.

**Accumulators.**

See Electrical Engineering, Electro-Chemistry.

**Boilers.**

See Mechanical Engineering, Steam Engineering.

**Carburetter.**

An Automatic Carburetter for Internal Combustion Motors (Sur un Carburateur Automatique pour Moteurs à Explosions). A. Krebs. Illustrated description of a self-regulating carburetter, well adapted for automobile vehicles or for stationary motors. 1500 w. Comptes Rendus—Nov. 24, 1902. No. 52441 D.

**Coupe.**

First Peugeot Coupé Imported into the United States. Illustrates and describes a luxurious novel motor cab. 900 w. Auto & Motor Rev—Dec. 13, 1902. No. 52296.

**Crestmobile.**

The Automobile Carriage in Its Simplest Form. Brief illustrated description of a vehicle which aims at simplicity in design. 600 w. Auto & Motor Rev—Dec. 13, 1902. No. 52297.

**Engines.**

Two-Cycle Automobile Engines. E. W. Roberts. On their adaptability to automobile propulsion. 1200 w. Sci Am—Nov. 29, 1902. No. 52044.

**Fire Engines.**

Some Foreign Motor Fire Engines. Illustrated descriptions of fire apparatus run by alcohol, steam and electricity. 1200 w. Munic Jour & Engr—Dec., 1902. No. 52-149 C.

**French Cars.**

Industrial Motor Cars in France. The first of a series of articles on the progress shown in these vehicles as illustrated at the recent trials. Describes and illustrates some of the cars. 2100 w. Engr, Lond—Dec. 5, 1902. Serial. 1st part. No. 52367 A.

**Gasoline Vehicles.**

Gasoline Motor Car in the Canadian Rockies. Illustrates and describes an observation car built for use of guests in the Rocky and Selkirk mountains. 800 w. Loc Engng—Dec., 1902. No. 52155 C.

The Sources of Noise in Gasoline Vehicles. Albert L. Clough. Considers the engine noises, the transmission gear noises and running gear noises. 2500 w. Horseless Age—Dec. 3, 1902. No. 52152.

**Generating Set.**

Improved Generating Set for Mixed Automobiles (Nouveau Groupe Electrogène pour Automobiles Mixtes). J. A. Montpellier. Describing a combination of de Dion Bouton gasoline motor and an electric generator for use on an electric automobile. 1500 w. L'Electricien—Dec. 6, 1902. No. 52481 B.

**Hill Climbing.**

The Eagle Rock Hill Climbing Trial. An account of the contest held by the New Jersey Automobile Club on Thanksgiving Day. Ill. 1700 w. Horseless Age—Dec. 3, 1902. No. 52154.

**Motor Cycles.**

Motor Cycle Matters. A. J. Wilson. Remarks on the exhibits at the Stanley and National Cycle shows, and the features of interest in the designs. 2200 w. Autocar —Nov. 29, 1902. No. 52176 A.

**Petrol Cars.**

The "Watsonia" Petrol Cars. Illustration, with a description of these cars, which are said to rank among the best of their class. 800 w. Auto Jour—Nov. 29, 1902. Serial. 1st part. No. 52177 A.

**Review.**

Automobiles (Le Automobiles). M. Forestier. A general review of the present state of automobile construction based on the exhibits at the Paris Exposition of 1900. 15,000 w. Ann des Ponts et Chausées—2 Trimestre, 1902. No. 52-447 E+F.

**Steam Car.**

The Chelmsford Steam Car. An illustrated description of a new steam car, fitted as a private omnibus. 1600 w. Horseless Age—Dec. 6, 1902. No. 52373.

The Chelmsford Steam Car. Illustrates and describes the mechanical details of this vehicle. 1200 w. Autocar—Nov. 29, 1902. Serial. 1st part. No. 52175 A.

**Traction Engine.**

The "Pedrail" Traction Engine. An illustrated description of an engine invented by B, J. Diplock which aims to imitate in principle the structure of the horse. 1300 w. Transport—Nov. 28, 1902, 1902. No. 52170 A.

**Truck.**

Morgan Motor Truck. Illustrates and describes a 10-ton truck made in Worcester, Mass. The steam is generated by oil, the boiler of the water-tube type. 3300 w. Auto Topics—Dec. 13, 1902. No. 52-300.

The Ten Ton Morgan Steam Truck. An illustrated detailed description. 1600 w. Horseless Age—Dec. 3, 1902. No. 52153.

Some Foden Steam Wagons. Illustrations of a covered van, tipping wagons, and haulage wagon, with brief description. 800 w. Autocar—Nov. 22, 1902. No. 52052 A.

**Voiturette.**

The "Traveller" Voiturette. Illustrated description of a machine that has proved itself reliable and durable. Its chief features are noted. 1800 w. Auto Jour—Nov. 22, 1902. No. 52053 A.

**Winter Service.**

Practical Winter Use of Automobiles. Harry B. Haines. An account of some winter experiences in using a gasoline vehicle. 2400 w. Horseless Age—Dec. 17, 1902. No. 52391.

## HYDRAULICS.

**Centrifugal Pumps.**

Flow Through Centrifugal Pumps. Jas. Alex. Smith. Read before the Victorian Inst. of Engrs. Illustrated notes on some experimental researches on internal flow in centrifugal pumps and allied machines. 3800 w. Engng—Dec. 5, 1902. No. 52-366 A.

Notes on some Experimental Researches on Internal Flow in Centrifugal Pumps and Allied Machines. James Alex. Smith. Paper read at Victorian Inst. of Engrs. (Revised.) An illustrated article showing simple means of recording photographically the course of the fluid current in typical equivalents of hydraulic machines, especially in the rotary parts. 3500 w. Sci Am Sup—Nov. 29, 1902. No. 52047.

**Excavation.**

The Cost of Hydraulic Excavation for Embankments and for Placer Mining. Abstracts of recent papers bearing upon this class of work are given with comments and tabulated information concerning cost. 2200 w. Eng News—Nov. 27, 1902. No. 52027.

**Flow.**

Some Characteristics of the Flow of Water in Channels of Varying Cross-Section. T. E. Stanton. An account of experiments undertaken to gain information concerning (1) the effect of the form of the channel; and (2) the effect of the angle of divergence on the loss of head involved. 2000 w. Engng—Nov. 21, 1902. No. 52071 A.

**Hydro-Electric Plant.**

See Electrical Engineering, Generating Stations.

**Pumps.**

High-Speed Pumps (Pompes à Grand Vitesse). M. Lecuir. A discussion of the action of valves and mechanism of high-speed power pumps by means of which shock may be minimised, with examples of recent construction. 6000 w. Revue de Mécanique—Nov. 30, 1902. No. 52435 E+F.

The Klein High-Speed Pump (Pompe Express à Grande Puissance Système Klein). O. Diemer. With illustrations showing the arrangement of valves and differential plunger, permitting speeds of 200 strokes per minute without shock. 1000 w. Revue Technique—Nov. 25, 1902. No. 52427 D.

**Sault Ste. Marie.**

Compensating Works at the Sault Canal. Waldon Fawcett. Illustrates and describes these interesting works, designed to equalize conditions by retarding and diverting from the rapids in the St. Mary's river a volume of water equal to the flow through the power canal. 1200 w. Am Mfr—Dec. 11, 1902. No. 52303.

The Giant Growth of the "Soo." Cy Warman. An illustrated account of the great industrial plants created by the power canals of Sault Sainte Marie. 2700 w. Rev of Revs—Dec., 1902. No. 52138 C.

**Turbines.**

Modern Turbine Practice and the Development of Water Power. John Wolf Thurso. Reviews the development of the turbine in Europe and America, present American turbine practice, types for low and high heads, general construction, etc. Ill. 10,000 w. Eng News—Dec. 4, 1902. No. 52166.

The Turbine Equipment of the "Soo." Brief illustrated description of this important development of water power. 700 w. Min Rept—Nov. 27, 1902. No. 52100.

**Water Meter.**

A Turbine Water Meter. An illustrated description of a water-wheel flow recorder for recording the discharge of a turbine, taking into account the effect of the degree of gate opening and of change of head. Designed by George I. Rockwood and C. M. Allen. 800 w. Eng Rec—Dec. 27, 1902. No. 52579.

**Water Motor.**

How to Make a Water Motor. R. E. Davall. Illustrated directions for a motor made by simple tools. 800 w. Sci Am Sup—Dec. 13, 1902. No. 52329.

**Water Power.**

An analysis of the "Commercial" Value of Water-Power per Horse-Power per Annum. A. F. Nagle. A method of calculating the value of a water-power for power purposes. 4500 w. Trans Am Soc of Mech Engrs, No. 0963—Dec., 1902. No. 52334 C.

**Weirs.**

See Civil Engineering, Canals, Rivers and Harbors.

## MACHINE WORKS AND FOUNDRIES

**Automobile Works.**

Some Motor Car Works. Begins an illustrated review of the English works for the building of motor vehicles, commenting on the rapid development of the industry. The present article describes the Thornycroft Works. 3600 w. Engr, Lond—Nov. 28, 1902. No. 52184 A.

**Bearings.**

Friction in High Speed Bearings (Die Reibungs verhältnisse in Lagern mit Hoher Umfangs geschwindigkeit). O. Lasche. A review of early and recent experiments, with data and results of tests at the A. E. G., confirming the investigations of Beauchamp Tower. Serial, Part I. 4500 w. Zeitschr d Ver Deutscher Ing—Dec. 13, 1902. No. 52411 D.

Transmission Bearings with Automatic Lubrication (Transmissionslager mit Selbstätter Schmierung). R. Kablitz. With descriptions of various forms of bearings, pillow blocks, and hangers; also data and results of efficiency tests. 3000 w. Zeitschr d Ver Deutscher Ing—Dec. 6, 1902. No. 52409 D.

**Boiler Shops.**

The Boiler Shops of the Babcock & Wilcox Company. Illustrates and describes the new plant at Bayonne, N. J., and also describes the construction of these boilers, which are of the sectional, water-tube type. 5000 w. Eng Rec—Dec. 6, 1902. No. 52243.

**Calipers.**

The Koopman Calipers. Ferd. Wertheim. An illustrated description of several calipers of superior design. 500 w. Am Mach—Dec. 4, 1902. No. 52163.

**Cost Keeping.**

See Industrial Economy.

**Dies.**

Eye-Glass Strap Dies. Frank Greiner. Drawings and descriptions of dies used in manufacturing these straps. 1500 w. Am Mach—Dec. 4, 1902. No. 52165.

**Electrical Driving.**

See Electrical Engineering, Power Applications.

**Electrical Works.**

The British Thomson-Houston Company's Works. Illustrated description of large works for the manufacture of electrical machinery. 5000 w. Tram & Ry Wld—Nov. 13, 1902. No. 52129 B.

**Foundries.**

Foundry. R. H. Palmer. A review of

the many improvements introduced during the last quarter of a century. 3700 w. Am Mach—Dec. 4, 1902. No. 52164.

The Foundry of the Saco & Pettee Machine Shops, Biddeford, Maine. An illustrated detailed description of this plant and its methods. 3500 w. Foundry—Dec., 1902. No. 52049.

**Foundry Management.**

Foundry Management in the New Century. Robert Buchanan. Mr. Buchanan's second paper discusses crane service and transport appliances for the foundry floor, with numerous characteristic illustrations. 4500 w. Engineering Magazine—January, 1903. No. 52487 B.

**Foundry Output.**

See Industrial Economy.

**Foundry Practice.**

Some Notes on English and Continental Foundry Practice. G. E. Pickup. An account of experiences, mostly in Great Britain, in a study of methods used for light castings. 1400 w. Foundry—Dec., 1902. No. 52050.

**Hardening.**

Shape as Affecting Hardening. Thomas Lovekin. Discusses the question of the effect of hardening upon the shape of steel articles, illustrating by an example where a slight change in construction made cracking impossible. 900 w. Am Mfr—Dec. 11, 1902. No. 52304.

**Machine Tools.**

A Large Horizontal Boring, Drilling and Milling Machine. An illustrated description of a machine of the heaviest type. 1500 w. Am Mach—Dec. 11, 1902. No. 52312.

Machine Tools. Jas. K. Cullen. On the present design, application and utility of these tools. Also discussion. 9500 w. W Ry Club—Nov. 18, 1902. No. 52338 C.

Machine Tools at the National Show. An illustrated review of the machine tools on exhibition at the Crystal Palace, London. 2700 w. Engng—Nov. 28, 1902. No. 52188 A.

**Marine Works.**

The Wallsend Slipway and Engineering Company. An illustrated description of British works for ship repairing and the building of marine engines and boilers. Also gives information concerning the important tools and some of the work undertaken. 2700 w. Engng—Nov. 28, 1902 No. 52187 A.

**Piece Work.**

See Industrial Economy.

**Pneumatic Tools.**

Principles, Care and Operation of Pneumatic Hammers and Tools. Refers more particularly to the construction and operation of the Boyer, Keller pneumatic hammers, and gives suggestions for the care of tools. 2800 w. Mod Mach—Dec., 1902. No. 52141.

**Screw Machines.**

The National-Acme Manufacturing Co. and Its Automatic Screw Machines. An illustrated article giving details of the manufacturing operations and of the machines. 2400 w. Ir Trd Rev—Dec. 4, 1902. No. 52158.

**Springs.**

A Diagram for Helical Springs. George F. Summers. Gives a chart for finding the size of helical springs, having given the properties, with explanation of its use. 700 w. Am Mach—Dec. 18, 1902. No. 52500.

**Wastes.**

Workshop Wastes: Time. W. J. May. Discusses some of the causes of wasted time of workmen. 1200 w. Prac Engr—Nov. 28, 1902. No. 52251 A.

**Welding.**

Rapid and Economical Method of Welding Locomotive Frames. Illustrates and describes the method of welding fractured frames in use in the shops of the Southern Pacific, which gives economy in cost and time. 1000 w. Ry & Engng Rev—Dec. 6, 1902. No. 52260.

## MATERIALS OF CONSTRUCTION.

**Alloys.**

Alloys of Copper and Magnesium (Sur les Alliages de Cuivre et de Magnesium). O. Boudouard. A record of a systematic series of tests of copper-magnesium alloys, with a brief account of their properties. 1000 w. Comptes Rendus—Nov. 10, 1902. No. 52438 D.

**Chemical Analysis.**

The Determination of the Value of Materials by Chemical Analysis (Die Chemische Analyse als Mittel Zur Bestimmung der Güte des Materials bei der Abnaline). O. Knaudt. A comparison of the results of physical tests with those obtained from chemical analysis, with especial reference to iron and steel. 1200 w. Zeitschr d Ver Deutscher Ing—Nov 15, 1902. No. 52402 D.

**Malleable Castings.**

Malleable Cast Iron. H. E. Diller. Describes the processes by which malleable iron is produced and gives information related. 1000 w. Jour Am Found Assn—Dec., 1902. No. 52142.

**Nickel Alloys.**

The Properties of Nickel-Iron and Nickel-Iron-Carbon Alloys (Die Eigenschaften von Nickel-Eisen und Nickel-Eisen-Kohlenstoff Legirungen). Data and results of tests made by the *Verein zur Beförderung des Gewerbfleisses.* 2500 w. Stahl u Eisen—Dec. 1, 1902. No. 52458 D.

**Strained Materials.**

A Possible Explanation of the Phenomena Caused by Repetitions of Stress. F. Foster. Read before the Owens College Engng Soc. A study of the effects of cyclical repetitions of stress on a material, and associated phenomena. 2500 w. Mech Engr—Nov. 22, 1902. Serial, 1st part. No. 52060 A.

## MEASUREMENT.

**Indicators.**

The Indicator as an Educator in Steam Engine Practice. S. J. Dillon. On the importance of understanding the indicator. Gives explanation of four cards. 800 w. Loc Engng—Dec., 1902. No. 52225 C.

**Indicator Springs.**

Testing Indicator Springs. Illustrated description of new apparatus at the New York Navy Yard for this purpose, giving details of construction and methods of testing. 2200 w. Mach, N Y—Dec., 1902. No. 52161.

**Mean Effective Pressure.**

A Graphical Determination of Mean Effective Pressure. Sidney Graves Koon. A series of curves, with explanation, of mean effective pressure in steam-engine cylinders, for the purpose of facilitating the preliminary design of engines. 800 w. Sibley Jour Mech Engng—Dec. 1, 1902. No. 52584 C.

## POWER AND TRANSMISSION.

**Air Compressor.**

Air Compressor for the Harpener Mining Company. An illustrated description of a compound air compressor, with Collmann valves, made by Schüchtermann and Kremer, of Dortmund, and exhibited at Düsseldorf. 1 plate. 700 w. Engng—Dec. 12, 1902. No. 52563 B.

Efficiency and Capacity Test of the Ingersoll-Sergeant Drill Co.'s Plant Installed for the Boston Transit Commission, Boston, Mass. R. S. Carter. Illustrated description of air-compressor plant to be used in driving a tunnel by the shield method, and record of tests. 1800 w. Compressed Air—Dec., 1902. No. 52536.

**Belts.**

Estimating Length of Driving Belts. Gives a graphical method and chart, either of which can be applied to the solution of these problems, with a formula for the length of crossed belts. 1200 w. Am Mach—Dec. 18, 1902. No. 52501.

**Compressed Air.**

Air Washer for Compressor Inlets. An illustrated description of a device for removing the dust and cleaning the air. 400 w. Compressed Air—Nov., 1902. No. 52372.

Compressed Air as a Transportation Agent. Waldon Fawcett. Considers some of the fields where this form of mechanical haulage is especially useful, giving illustrated descriptions of the locomotives used. 900 w. Sci Am—Dec. 13, 1902. No. 52324.

Compressed Air in the Foundry and Machine Shop. W. L. Saunders. An exhaustive study of the numerous uses of compressed air for sand blast, ramming, hammers, hoists, pneumatic tools, moulding machines, and other uses in machine works and foundries. 5000 w. Compressed Air—Dec., 1902. No. 52499.

**Conveyor.**

A Vibrating Conveyor System (Propellerrinnen und Wurfgetriebe). H. Marcus. An illustrated description of a device for conveying coal, grain, and similar materials in a vibrating open trough operated by a quick return crank movement. 3000 w. Zeitschr d Ver Deutscher Ing.—Nov. 29, 1902. No. 52407 D.

**Driving Chains.**

The Renold Silent Chain in Connection with Machine and Structural Tools. J. O. Nixon. An illusrated article setting forth the advantages of these chains. 1200 w. Mach, N Y—Dec., 1902. No. 52159.

**Gears.**

Worm Gearing. C. F. Blake. Notes on the design of self-locking worm gears. Ill. 2500 w. Mach, N Y—Dec., 1902. 52160.

**Shafting.**

Hanging New and Lining Up Old Shafting. D. B. Dixon. Directions for this work with remarks on care needed in determining the diameter of the shafting, the bearings, etc. 2200 w. Am Mfr—Dec. 4, 1902. No. 52146.

## SPECIAL MOTORS.

**Diesel Motor.**

The American Type Diesel Engine. An illustrated explanation of this form of engine. 1200 w. Elec Rev, N Y—Dec. 6, 1902. No. 52214.

**Explosive Mixtures.**

Some New Work on Properties of Explosives Mixtures. Charles E. Lucke. An illustrated account of experimental studies of explosive mixtures for heat engines. 5000 w. School of Mines Quar—Nov., 1902. No. 52559 E.

**Gas Engines.**

Application of Blast-Furnace and Producer Gas to Power Development. C. A. Dawley. A general review of the subject, with two illustrations of gas engines. 2400

w. Sibley Jour Mech Engng—Dec., 1902. No. 52586 C.

Blast-Furnace Gas Engines and Their Work. Extracts from a critical and descriptive paper by Director Reinhardt of Dortmund, Germany, presented at meeting of the Verein Deutscher Eisenhuettenleute, giving much new information. 2800 w. Ir Age—Dec. 4, 1902. Serial, 1st part. No. 52134.

Gas Engine Diagrams. W. H. Booth. An illustrated discussion of gas-engine indicator diagrams, and a comparison with steam engine diagrams. 1600 w. Elec Rev, Lond—Dec. 12, 1902. No. 52545 A.

Gas Engines for Electric Stations. G. H. Baillie. A general discussion of the operation of electric stations by gas engines and a comparison with steam engines. 3000 w. Engr, Lond (Elec Engng Sup)—Dec. 12, 1902. No. 52541 A.

Internal Combustion Motors and their Operation with Producer Gas, Furnaces Gases, etc. (Verbrennungs Kraftmaschinen und deren Betrieb mit Kraftgas, Hochöfengas, etc.). Joh. Körting. An extensive review of large power gas installations, with details of engines and producer plants. 6000 w. Glasers Annalen—Dec. 1, 1902. No. 52421 D.

Suction Producers for Gas Engines. Abstract translation of a paper by Herr J. Korting in the *Journal für Gasbeleuchtung*. Gives an illustrated description of the Korting power-gas plant and discusses the suction generators for making producer gas without the aid of a boiler. 4000 w. Jour Gas Lgt—Nov. 25, 1902. No. 52174 A.

Suction Gas Producer for Anthracite (Gazogène à l'Anthracite pas Aspiration). E. François. Illustrating a convenient form of gas producer with reversed draft, suitable for generating lean fuel gas for medium and small sized gas engines. 8000 w. 4 plates. Rev Univ des Mines—Nov., 1902. No. 52446 G.

The Koerting Gas Engine. Illustration with description of this large gas engine and its operation. 1200 w. R R Gaz—Dec. 5, 1902. No. 52222.

The Use of Blast Furnace Gas in Gas Engines. Cecil A. Cochrane. A paper before the Cleveland Institution of Engineers, giving a description of a 600-horse-power Cockerill gas engine, installed at the Ormesby Iron Works, Middlesborough, Eng., and the experience in operating it with blast-furnace gas. Also editorial review. Serial. Part I. 4000 w. Engng—Dec. 12, 1902. No. 52566 B.

Three-Cylinder Compound Gas Engine. An illustrated description of a 100-horse-power compound gas engine constructed by Clarke, Chapman and Co., under Mr. Butler's patents, with a set of indicator cards. 600 w. Engr, Lond—Dec. 12, 1902. No. 52540 A.

See also Electrical Engineering, Generating Stations; Mining and Metallurgy, Iron and Steel.

**Mond Gas.**

See Gas Works Engineering.

## STEAM ENGINEERING.

**Balancing.**

The Balancing of Rolling Mill Engines. George Service. Read before the West of Scotland Ir. & Steel Inst. Considers (1st) the work actually being performed by the engine; (2d) the actions taking place in the various parts of the engines and their effect on the engine as a whole, while performing this work. 3000 w. Ir & Coal Trds Rev—Nov. 28, 1902. No. 52249 A.

**Boiler Explosion.**

Boiler Explosion at Swift & Co.'s Plant, Chicago. An illustrated account of an accident involving great loss of life and destruction of property. 2300 w. Steam Engng—Dec. 10, 1902. No. 52306.

**Boilers.**

A Competitive Test of Steam Boilers. Reports a competitive test at the power station of the Rapid Transit Co., in Philadelphia, of a Parker boiler and the regular Babcock & Wilcox boiler. 4000 w. Eng News—Nov. 27, 1902. No. 52036.

Computing the Strength of Tubular Boilers. Charles L. Hubbard. Directions for calculating the resistance of a boiler to internal pressure, illustrating by example. 1800 w. Am Elect'n—Dec., 1902. No. 52246.

Flash Steam Generators. J. S. V. Bickford. Notes on the writer's experience in designing and using such generators. 3500 w. Horseless Age—Dec. 17, 1902. No. 52392.

Modern Production of Boiler Draught and Its Influence on Fuel Consumption and Steam Production. W. L. Sutcliffe. Paper before the Manchester Assn. of Engrs. A discussion of mechanical or machine draft producers. Does not deal with steam jet apparatus. 1700 w. Mech Engr—Nov. 29, 1902. No. 52254 A.

Naval Tests of a Water-Tube Boiler. An illustrated account of tests made at Washington, D. C., of a Hohenstein boiler, one series with coal and another with oil fuel. The trials were made by U. S. naval officers, in a steel house similar to the fire room of a cruiser, and are recorded in Admiral Melville's annual report. Tables. 1500 w. Eng Rec—Dec. 20, 1902. No. 52571.

The Management and Working of

Steam Boilers. William H. Fowler. Treats of the arrangement, working and equipment of steam boilers and auxiliary appliances from the practical standpoint of the steam user, the superintending engineer, the boiler inspector, and the attendant. Ill. 1800 w. Mech Engr—Nov. 22, 1902. Serial. 1st part. No. 52058 A.

**Calorimetry.**

The Effect of Impurities in Compressed Oxygen upon Combustion in the Calorimetric Bomb (Sur les Impuretés de l' Oxygène Comprimé et sur leur Rôle dans les Combustions Opérées au Moyen de la Bombe Calorimetrique). M. Berthelot. An examination of the impurities found in commercial compressed oxygen, showing especially the possible errors produced by the presence of hydrogen, when used in the calorimetric bomb. 1500 w. Comptes Rendus—Nov. 17, 1902. No. 52439 D.

**Chimney.**

The Demolition of a 150-Ft. Brick Chimney by Dynamite. W. J. Douglas. An illustrated account of the means recently adopted at Washington, D. C., to demolish a brick chimney, with approximate cost of the work. 1000 w. Eng News—Dec. 4, 1902. No. 52168.

**Condensers.**

Central Condensers (Zentral-Kondensationen). H. Dubbel. An illustrated description of the central condensing systems shown at the Düsseldorf exposition. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 29, 1902. No. 52408 D.

**Continental Practice.**

Steam Engineering in Continental Europe. A. Bollinckx. Reports an unsettled period, and reviews the improvements in course of trial. 900 w. Power—Dec., 1902. 52268 C.

**Corliss Engines.**

The Early History of the Corliss Engine in the United States. George R. Phillips. Read before the Engine B'ld'rs Assn. 4800 w. Ir Age—Dec. 4, 1902. No. 52136.

**Drips.**

The Disposal of Drips. C. G. Robbins. Considers the handling of "low-pressure" and "high-pressure" drips of condensed steam. Ill. 2500 w. Power—Dec., 1902. No. 52271 C.

**Engine Design.**

Freaks and Fallacies in Steam Engine Design. Egbert P. Watson. Accounts of some of the fallacious designs which have been brought out to revolutionize steam engineering practice; showing the only true tests to be fuel consumption and accurate power measurement. 2500 w. Engineering Magazine—January, 1903. No. 52486 B.

**Engines.**

Recollections of the Early Days of the High Speed Engine Industry. John E. Sweet. Read before the Engine B'ldrs. Assn. of the U. S. 3500 w. Ir Age—Dec. 11, 1902. No. 52256.

**Engine Tests.**

Final Report of the Committee Appointed to Standardize a System of Testing Steam Engines. 20,000 w. Ill. Trans Am Soc of Mech Engrs, No. 0957—Dec., 1902. No. 52088 D.

Discussion on Report of Committee on Standardizing Engine Tests. All discussion that has been offered on the report at meeting and in writing. 19,800 w. Ill. Trans Am Soc of Mech Engrs, No. 0958—Dec., 1902. No. 52089 D.

**Firing.**

On Firing with Soft Coal. Re-print of an article published by this same paper thirteen years ago, on the management of soft coal fires. Ill. 1200 w. Locomotive—Oct., 1902. No. 52262.

**Fuels.**

Liquid Fuel. Presents the advantages over coal and coke, and thinks it only needs to have the furnaces for its use correctly designed to demonstrate its great economy. 800 w. Am Engr & R R Jour—Dec., 1902. No. 52113 C.

Recent Developments in the Economy and Variety of Fuel. E. H. S. Bailey. Remarks on recent investigations for producing greater saving in combustion, and the development of new fuels. 1800 w. Pro Age—Dec. 15, 1902. No. 52339.

The Possibilities of New Fuel. George Ethelbert Walsh. Concerning the study of available fuels brought about by the recent strike, and the indications of more economical use, and preparations for future power. 2500 w. Power—Dec., 1902. No. 52267 C.

The Present State of the Question of Liquid Fuel. Considers briefly the economy, the difficulty of satisfactorily burning moderate quantities of oil, the uses, etc. 2000 w. Jour Gas Lgt—Dec. 2, 1902. No. 52375 A.

**Generating Sets.**

See Electrical Engineering, Generating Stations.

**Governor.**

Robinson's Shaft Governor. An illustrated description of a spring shaft governor for steam engines. 400 w. Engng—Dec. 12, 1902. No. 52567 B.

**Great Britain.**

The Present Condition of Steam Engineering in Great Britain. W. H. Booth. Reviews the changes of the past twenty years, criticising some points. 4300 w. Power—Dec., 1902. No. 52270 C.

**Heating.**

Heating the Washington Heights Free Library, New York. An illustrated description of a steam-heating system, principally by indirect radiation. Plans. 1200 w. Eng Rec—Dec. 27, 1902. No. 52581.

Steam Heating. George Bennett. A review of the methods of heating buildings by steam, describing each briefly and discussing the production and distribution of heat. 3000 w. Engr, U S A—Dec. 1, 1902. No. 52150.

**Heat Transmission.**

The Relation of Heat Emission to Steam Pressure (Zur Generellen Regelung der Wärmeabgabe der Heizkörper bei Niederdruck durch die Höhe der Dampfspannung). O. Hunaeus. A discussion of Rietschel's formula, showing its applicability to steam and hot-water heating. 2500 w. Gesundheits-Ingenieur—Nov. 15, 1902. No. 52476 B.

The Relation of Heat Emission to Steam Pressure (Zur Generellen Regelung der Wärmeabgabe der Heizkörper bei Niederdruck durch die Höhe der Dampfspannung). Prof. Rietschel. A review of the use of his formula by Herr Hunaeus. 2500 w. Gesundheits-Ingenieur—Nov. 30, 1902. No. 52477 B.

The Transmission of Heat Through Heating Surfaces (Ueber den Wärmedurchgang durch Heizflächen). L. Austin. Data and results of tests made at the Reichsanstalt, with description of the apparatus. 3000 w. Zeitschr d Ver Deutscher Ing—Dec. 13, 1902. No. 52412 D.

**Indicators.**

See Mechanical Engineers, Measurement.

**Lubrication.**

Automatic Cylinder Lubrication. C. G. Robbins. Discusses the hydrostatic lubricator, stating objections to its use, and describes "pressure" systems in common use. Ill. 1800 w. Power—Dec., 1902. No. 52272 C.

Lubrication. William F. Parish, Jr. Abstract of a paper presented to the New England Cotton Mfrs. Assn. Considers the selection of oils; cylinder, engine, dynamos, and shafting lubrication. 3500 w. Power—Dec., 1902. No. 52273 C.

**Mechanical Draft.**

Mechanical Draft for Modern Steam Boiler Plants. S. R. Sheldon. Considers the opportunities for economy by the application of mechanical draft, and related subjects. 2200 w. Can. Engr—Dec., 1902. No. 52207.

**Oil Fuel.**

See Marine Engineering.

**Pipe Covering.**

Steam Pipe Covering and Its Relation to Station Economy. H. G. Stott. Read before the Assn. of Edison Ill. Co.'s. Results of a series of tests made in the interest of the Manhattan Ry. Co. Describes method of testing and discusses results. 3300 w. Elec Rev, N Y—Nov. 29, 1902. No. 52106.

**Pulverized Coal.**

The Rowe System of Burning Pulverized Coal. An illustrated description of a system using bituminous slack under the boilers in the works of the C. O. Bartlett & Snow Co., of Cleveland, Ohio. 500 w. Eng Rec—Dec. 20, 1902. No. 52574.

**Refuse Destructors.**

See Civil Engineering, Municipal; and Electrical Engineering, Generating Stations.

**Rotary Engine.**

The Patschke Rotary Steam Engine (Die Rotations-Dampfmaschine System Patschke). With numerous illustrations of details for a rotary engine of the radial eccentric-arm type. 1500 w. 1 plate. Glückauf—Dec. 6, 1902. No. 52456 D.

**Smoke Prevention.**

The Smoke Problem and Its Possibilities. W. C. Popplewell. A discussion of the methods for preventing smoke, and an illustrated description of several mechanical stokers. 6000 w. Feilden's Mag—Dec., 1902. No. 52557 B.

**Speed Recorder.**

Apparatus for Obtaining a Continuous Record of the Position of an Engine Governor and the Speed of the Engine which It is Governing. Joseph C. Riley. Describes experiments performed at Nason College, Birmingham, England, on the action of governors when detached from their engines, and also a similar set of experiments at the Massachusetts Inst. of Technology. Ill. 4800 w. Trans Am Soc of Mech Engrs, No. 0971—Dec., 1902. No. 52087 C.

**Steam Piping.**

High Pressure Steam Piping. William Andrews. Read before the Engine B'ldrs. Assn. of the U. S. Reviews briefly the development of the past 20 years, and discusses the design, material, and the disposing of the water. 2400 w. Ir Age—Dec. 11, 1902. No. 52258.

**Steam Turbines.**

Steam Turbines: With Special Reference to the De Laval Turbine. Konrad Anderson. Read before the Inst. of Engrs. & Shipbuilders in Scotland. Illustrates and describes the construction and working of the Parsons, De Laval and Rateau turbines. 2500 w. Mech Engr—Dec. 6, 1902. Serial. 1st part. No. 52379 A.

The Present Development of the Steam Turbine. Edwin Yawger. Read at the Columbus meeting of the Ohio Elec. Assn. An illustrated article describing the action and mechanical details. 1500 w. Elec Wld & Engr—Dec. 6, 1902. No. 52265.

See also Marine Engineering.

**Superheating.**

Superheated Steam. E. H. Foster. From a paper before the Engine Bldrs' Assn. Considers the advantages and disadvantages of superheating, describes the Schmidt system, the benefits of moderate superheating, and the use of superheated steam. 3000 w. Ir Age—Dec. 4, 1902. No. 52135.

**Valve Seats.**

The Boring of Corliss Valve Seats (Alésage des Glaces Circulaires des Cylinders à Distribution Corliss). M. Chand. With illustrations of forms of valve seats, and details of portable machine for reboring them in position. 2500 w. Revue Technique—Nov. 25, 1902. No. 52430 D.

**Vibrating Engine.**

The Sleeper Patent Steam Engine. G. D. Hartley. Illustrates an engine recently invented by Frank H. Sleeper, of Montreal, that has many novel features. 1800 w. Can Elec News—Dec., 1902. No. 52299.

### MISCELLANY.

**Aeronautics.**

The Langley Aërodrome. An illustrated article describing this flying machine. The present number is a reprint of papers from the Smithsonian report for 1900, and from McClure's Magazine. 4400 w. Sci Am Sup—Nov. 29, 1902. Serial. 1st part. No. 52046.

**Combustion.**

The Temperature of Inflammation and Combustion of the Three Varieties of Carbon (Sur la Temperature d'Inflammation et sur la Combustion, dans l'Oxygéne, des Trois Variétés de Carbone). H. Moissan. A detailed study of the combustion of carbon in oxygen, including experiments with diamond, graphite, and amorphous carbon. 2000 w. Comptes Rendus —Dec. 1, 1902. No. 52442 D.

**Compression.**

Critical Points and their Importance in the Compression of Gases (Die Kritischen Daten und ihre Bedeutung für die Kondensation der Gase). Dr. Clemens Schaefer. A discussion of the influence of critical temperatures upon the behavior of gases under pressure. 3000 w. Zeitschr d Ver Deutscher Ing—Dec. 13, 1902. No. 52413 D.

**Heating.**

Heating and Ventilating the Akron, O., Jail. Illustrated description of a building which is a departure from the general prison plan, and of its combined forced and inducted hot air system of heating and ventilating. 2000 w. Eng Rec—Nov. 29, 1902. No. 52123.

The Reck System of Hot Water Heating (Die Warmwasserheizung System Reck). Ernst Schiele. The circulation is maintained by a form of jet pump operated from the heating boiler. Details of the system and its connections are given. Two articles, 4000 w. Gesundheits—Ingenieur—Nov. 15, 30, 1902. No. 52475 each B.

Ventilation and Heating in a Philadelphia Department Store. Illustrated description of methods adopted for heating a large building when each floor is practically a single room. A combined plenum and exhaust system. 3500 w. Eng Rec—Dec. 13, 1902. No. 52349.

Wood Furnace Heating in Nova Scotia. An illustrated description of arrangements for heating a building with a wood hot air furnace. 1800 w. Metal Work—Nov. 29, 1902. No. 52041.

**Refrigeration.**

Different Methods of Producing Cold. The Absorption and Compression Systems. Oswald Gueth. Presented before the James Watt Assn., N. A. S. E. The first of three lectures on this subject. 5700 w. Engr, U S A—Dec. 1, 1902. No. 52151.

Shutting Down an Ice Plant. William Nottberg. Illustrated directions for the proper care of the plant. 1400 w. Power—Dec., 1902. No. 52269 C.

## MINING AND METALLURGY

### COAL AND COKE.

**Aguilar District.**

Aguilar Coal and Oil District. Prof. Arthur Lakes. A description of the geology, the thickness and quality of the coal veins, and the indications of oil in this field in Colorado and New Mexico. 3300 w. Mines & Min—Dec., 1902. No. 52196 C.

**Anthracite.**

The Anthracite of the Third Hill Mountain, West Virginia. William Griffith. Situation, topography and geology of this region. 4500 w. Jour Fr Inst—Dec., 1902. No. 52341 D.

**Briquetting.**

Apparatus for Compressing Coal before

Coking (Installation pour la Compression du Charbon avant sa Transformation en Coke). With illustrations of the briquetting plant of Kuhn & Co. of Bruch, with plate of details. 1200 w. 1 plate. Génie Civil—Nov. 15, 1902. No. 52423 D.

**By-Products.**

Plant for Saving Coke By-Products. Abstract translation of an article by Dr. Bertelsmann, in the *Zeitschrift für Berg-Hutten und Salinenwesen*. Describes the extension of the coal distillation plant at the Matthias Stinnes mine in Carnap, Germany. 2800 w. Mines & Min—Dec., 1902. No. 52199 C.

**Coal Cleaning.**

Studies on Coal Washing. L. Moulan, in *Soc. Ingen. Ecole d'Industre du Hainaut*. Deals with the operation from the standpoint of the management of the washing water and the recovery of the sludge. Ill. 1800 w. Col Guard—Nov. 21, 1902. No. 52068 A.

The Allard Coal Separator (Separation der Kohlenach dem Verfahren von François Allard). Describing an improved form of jigging machine used in Belgium for separating coal from impurities by gravity. 1800 w. Glückauf—Nov. 29, 1902. No. 52455 D.

The Schüchtermann & Kremer and Humboldt Coal-Classifying Plant. Illustrated description of the coal-classifying and washing plant in use at the Grillo shaft of the Monopol Colliery, for dealing with 100 tons of coal per hour. 1400 w. Col Guard—Dec. 5, 1902. No. 52356 A.

**Coal-Fields.**

The Early Leicestershire Coal Field (1204-1832). Deals with the Cole Orton and Moira districts, giving a historical review. 3300 w. Col Guard—Nov. 21, 1902. Serial. 1st part. No. 52070 A.

**Coal Formations.**

The Mountain Formations of the Rhenish-Westphalen Coal District (Das Deckgebirge des Rheinisch-Westfälischen Carbons). H. Schulz-Briesen. A geological study of the mountains overlying the so-called Münster coal basin. 5000 w. 2 plates. Glückauf—Nov. 8, 1902. No. 52453 D.

**Coking.**

Coking in Bee-Hive Ovens with Reference to Yield. Charles Catlett. Calls attention to the waste, the need of careful records, and what the records should show to determine where improvements are needed. 3800 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 52281 D.

The Brunck System of By-Product Coke Ovens. Illustrates and describes the construction principles and operation of these ovens. 3000 w. Ir & Coal Trds Rev—Dec. 5, 1902. No. 52362 A.

**Depreciation.**

Depreciation as Affecting Collieries and Iron Works. H. A. Foster. Considers some of the usual methods of treating depreciation, and some that are less commonly considered. 3700 w. Ir & Coal Trds Rev—Nov. 21, 1902. No. 52081 A.

**German Coke.**

The German Coke Industry. Concerning the Rhenish-Westphalian Coke Syndicate and the price of blast furnace coke. 1400 w. Col Guard—Dec. 5, 1902. No. 52355 A.

**Japan.**

The Takasima Coal Mines, Japan. Abstract of a paper read by E. W. Nardin before the Australasian Inst. of Min. Engrs. Describes the mines and methods of working. 1100 w. Col Guard—Nov. 21, 1902. No. 52069 A.

**Pulverized Coal.**

See Mechanical Engineering, Steam Engineering.

**Queensland.**

Coal in the Cook District. C. F. V. Jackson. An account of the prospecting thus far, the deposits found, etc. Ill. 2000 w. Queensland Gov Min Jour—Oct. 15, 1902. No. 52172 B.

**Scotland.**

The Cost of Working Coal in Scotland. R. W. Dron. Discusses the increased cost of mining, the causes and the remedies. 2000 w. Ir & Coal Trds Rev—Dec. 5, 1902. No. 52358 A.

**Waste.**

The Waste in Working Coal in Great Britain. Walter S. Wardlaw. Prize essay. An illustrated article considering the two main systems of working coal, and the progress toward economy in waste in working. 1700 w. Ir & Coal Trds Rev—Dec. 5, 1902. No. 52357 A.

**West Virginia.**

Red Jacket Coal and Coke Co. Mines in Logan County, West Virginia. Frank A. Hill. An illustrated description of the coal, the mines and methods of handling. 2200 w. Mines & Min—Dec., 1902. No. 52195 C.

## COPPER.

**Mexico.**

The Cananea Copper Deposits, Mexico. Walter Harvey Weed. An illustrated description of the district, the peculiarities of the ore, and matters of interest. 1700 w. Eng & Min Jour—Dec. 6, 1902. No. 52239.

**New Mexico.**

The Burro Mountain Copper District,

New Mexico. George D. Reid. An illustrated account of this district and its ores. 1400 w. Eng & Min Jour—Dec. 13, 1902. No. 52342.

**Peru.**

A Great Copper District in Peru. Extract from an article in the London *Economist* giving an account of the Cerro de Pasco mines. 1600 w. Ir Age—Dec. 4, 1902. No. 52131.

See Electrical Engineering, Electro-Chemistry.

## GOLD AND SILVER.

**Amalgamation.**

A Study of Amalgamation Methods, Especially the Patio Process, with the Object of Avoiding the Loss of Mercury. Miguel Bustamente, Jr. Describes the character of the ore to be treated and gives an account of the experimental investigations. 5400 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 52280 D.

**Brazil.**

The Gold-Field of the State of Minas Geraes, Brazil. Herbert Kilburn Scott. Information in regard to this field collected by the author during a five years' residence in the State. Illustrated descriptions of individual mines, methods of work, occurrence, etc. 9700 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 52282 D.

**British Columbia.**

Notes from the Atlin District, British Columbia. W. M. Brook. An illustrated article giving information of the progress made by the companies operating in this region. 2200 w. Eng & Min Jour—Nov. 29, 1902. No. 52110.

**Camp Bird.**

The Camp Bird Gold Mine and Mill. H. A. Titcomb. An illustrated description of this mine and mill in the San Juan region, in southwestern Colorado. 2500 w. School of Mines Quar—Nov., 1902. No. 52560 E.

**Coeur d' Alenes.**

The Mining Industry of Coeur d'Alenes, Idaho. J. R. Finlay. Illustrates and describes this silver-lead district, its geology and resources; the veins and ore deposits; methods of operation, etc. Map. 6500 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 52278 D.

**Concentration.**

Development of Coarse Concentration in the Slocan District. Samuel S. Fowler. From the Canadian Min Inst. Considers what has been done toward working these deposits economically. 5500 w. B C Min Rec—Dec., 1902. No. 52388 B.

**Cyanide Process.**

Cyaniding Concentrates by Percolation at Choukpazat. C. M. Wright. Paper before the Institute of Mining and Metallurgy, London, on the treatment of gold ore concentrates consisting of 30 to 40 per cent. sulphides and 60 to 70 per cent. coarse sands, in Burma. 1000 w. Eng & Min Jour—Dec. 20, 1902. No. 52595.

Cyaniding Silver Ores. R. Stuart Browne. An account of some of the work which is being done in Nevada, in applying the cyanide process to the treatment of silver ores. 1400 w. Min & Sci Pr—Dec. 13, 1902. No. 52597.

The Filter Press Process of Cyanidation of Slimes. E. Barton Hack. Describes this method of treatment, stating its advantages. Ill. 1500 w. Min Rept—Dec. 11, 1902. No. 52386.

The Treatment of Cupriferous Gold Ores by Cyanide of Potassium. Louis Janin, Jr. A description of several processes for treating gold ores containing copper, and particularly of Bertram Hunt's method of leaching with an ammoniacal cyanide solution. 2000 w. Eng & Min Jour—Dec. 20, 1902. No. 52594.

**Dredges.**

Gold Dredges—Their Construction and Manipulation. David K. Blair. Read before the N. S. W. Chamber of Mines. A description of the "Bucket Gold Dredge," the general principles of construction and manipulation, the accidents liable, with their cause, effect and remedy. 9000 w. Can Min Rev—Nov. 30, 1902. Serial. 1st part. No 52105 B.

**Guiana.**

Gold in Venezuelan Guiana (L'Or en Guyane Vénézuélienne). Norbert Paquet. A geological study of Venezuelan Guiana with reference to the gold deposits and present methods of working, with map. 12000 w. 1 plate. Rev Univ des Mines—Nov., 1902. No. 52445 G.

**Hydraulic Mining.**

Low-Grade Gravel Property. Illustrated description of a property in California, where the supply of water is brought 30 miles, and the expense of maintenance is rather high. Gives results showing profits. 1300 w. Min & Sci Pr—Dec. 6, 1902. No. 52387.

The Hydraulic Installation at the Panuco Mines in Mexico. Horace L. Short. Abstract of a paper read before the Inst. of Min & Met., London. Description of the water-power system of this gold and silver mining property. 2000 w. Eng & Min Jour—Dec. 6, 1902. No. 52241.

**La Plata.**

The La Plata Mountains. Prof. Arthur Lakes. Observations on their formations and the influence of the different igneous rocks upon mineralization. Ill. 2300 w. Mines & Min—Dec., 1902. No. 52203 C.

**"Marauding."**

"Marauding" in French Guiana. David Levat. The term indicates a prospector or placer miner who practices his industry on any gold-bearing territory regardless of the legal proprietor, and is not locally considered at all disgraceful. 1800 w. Eng & Min Jour—Dec. 13, 1902. No. 52344.

**Mechanical Feeding.**

Mechanical Feeding of Silver-Lead Blast Furnaces. Arthur S. Dwight. Considers the present state of the art and describes devices which have come under the personal observation of the writer, recording his results in the practical working of one of the systems. Ill. 12800 w. Trans Am Inst of Min Engrs—Nov., 1902. No. 52277 D.

**Mexico.**

The Prieta Mine of Parral, Mexico. S. M. Terry. Gives the history of this noted silver mine and an account of its reopening after being flooded for many years. Ill. 1200 w. Eng & Min Jour—Dec. 6, 1902. No. 52238.

**Smelter.**

The New Bully Hill Smelter. Illustration, with description of the works, in California, the deposits, etc. The ores carry copper, gold and silver. 1700 w. Eng & Min Jour—Dec. 6, 1902. No. 52-240.

**Sulphide Ores.**

A Dry Process for the Treatment of Complex Sulphide Ores. H. L. Sulman and H. K. Picard. A paper read before the Inst. of Mining and Metallurgy, London, describing a process for treating ores in which are zinc blende and galena, as well as silver. Present practice in Australia is reviewed. 5400 w. Can Min Rev—Nov. 30, 1902. No. 52104 B.

## IRON AND STEEL.

**Brazil.**

The Iron Ores of Brazil. Herbert Kilburn Scott. Abstract of a paper read before the Inst of Min. & Met., London. Information concerning very large deposits of fine quality. 1300 w. Eng & Min Jour —Dec. 6, 1902. No. 52242.

**Briquetting.**

Briquetting Iron Flue Dust. R. M. Hale. Describes the methods employed in the manufacture of briquettes, discussing important points, and conclusions from actual operation. 3500 w. Ir Age—Dec. 11, 1902. No. 52257.

**Electric Driving.**

See Electrical Engineering, Power Applications.

**Electric Smelting.**

See Electrical Engineering, Electro-Chemistry.

**Gas Engines.**

See Mechanical Engineering, Special Motors.

**Great Britain.**

The Iron and Steel Industries of Great Britain—Their Conditions and Outlook. J. Stephen Jeans. Abstract of a lecture before the students of Birmingham University. Considers the conditions upon which success depends, and how far these are met. 3000 w. Ir & Coal Trds Rev—Dec. 5, 1902. No. 52361 A.

**Ingots.**

Chemical Composition of Steel Ingots. Alex. Wahlburg. Discusses the objects of piping and blow-holes in ingots and their causes and prevention, giving a digest of Brinell's work, with which the writer agrees. 4600 w. Am Mfr—Nov. 27, 1902. Serial. 1st part. No. 52098.

**Iron Ores.**

A Comparison of the Origin and Development of the Iron Ores of the Mesaba and Gogebic Iron Ranges. Kenneth Leith. Abstract of a paper presented to the Lake Superior Min. Inst. Outlines and compares certain conclusions reached by the U. S. Geol. Survey. 2700 w. Ir Age—Dec. 4, 1902. No. 52133.

**Rolling.**

The Laws of the Rolling of Iron (Lois du Laminage du Fer). R. Tonkow. A study of the relation of the diameter and speed of rolls to the extent of reduction of the metal at each pass. 8000 w. Rev Univ des Mines—Oct., 1902. No. 52444 G.

**Slag.**

The Composition of Blast Furnace Slag (Ueber die Constitution er Hochofenschlacke). Karl Zulkowski. A review of the theory of Jüptner, with formulas indicating the reactions involved in the formation of furnace slag. Two articles, 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 6, 1902. No. 52460 each D.

**Valves.**

Water Controlled Forter Reversing Valve. Illustrated description of a new style of gas valve for regenerative furnaces. 1600 w. Ir Age—Dec. 18, 1902. No. 52393.

## MINING.

**Anemometers.**

The Anemometer Testing Station of the Westphalian Mining Bureau at Bochum (Die Anemometer-Prüfungstation der Westfälischen Berggewerkschaftskasse in Bochum). H. Stach. With details of the construction and use of the whirling apparatus for testing the anemometers used in measuring ventilating current in mines. 2000 w. 1 plate. Glückauf—Nov. 22, 1902. No. 52454 D.

**Bench Method.**

Mining on the Bench Method of Working Adapted to Peculiar Conditions in the Clinch Valley Field of Southwestern Virginia. Charles Colcock Jones. Describes the conditions and the methods of working. 1000 w. Mines & Min—Dec., 1902. No. 52200 C.

**Colorado.**

The Soils of Colorado. Prof. Arthur Lakes. Considers their nature in relation to their geological origin and surroundings, and their availability for irrigation. 3200 w. Mines & Min—Dec., 1902. No. 52198 C.

**Development.**

Our Mining Interests. Prof. J. A. Holmes. Read before the International Mining Congress. Discusses some of the factors contributing to and influencing American mining development. 3700 w. Mines & Min—Dec., 1902. Serial. 1st part. No. 52202 C.

**Drilling.**

Method of Drilling and Shutting Off Water in Experimental Boreholes. Bergassessor Jacob, in *Glückauf*. Describes a method adopted to meet unusual conditions, which, with some alterations, is capable of being adapted to the boring to faults in the vicinity of old workings, etc. Ill. 1300 w. Col Guard—Nov. 28, 1902. No. 52194 A.

**Earth Movements.**

Recent Earth Movements. Prof. Arthur Lakes. An account of some movements in the Rocky Mts. as shown by effects on streams and mines. 1500 w. Mines & Min—Dec., 1902. No. 52204 C.

**Electric Power.**

See Elec. Engng., Power Applications.

**Fans.**

On Experiments with Duplicate Ventilating Fans at Bamfurlong Collieries. J. W. Hutchinson. Read before the Manchester Geol. Soc. A statement of conditions to be met, and an account of experiments made, illustrations of the present arrangement of engines and fans, with table of tests and measurements made. 1800 w. Ir & Coal Trds Rev—Nov. 28, 1902. No. 52250 A.

**Head Frame.**

An Eldorado County, Cal., Head Frame. C. H. Wildman. An illustrated description of a new head frame recently erected on the Flagstaff shaft of the Mt. Hope mine. 700 w. Min & Sci Pr—Nov. 29, 1902. No. 52212.

**Hoisting.**

Hoisting from Great Depths. Hennen Jennings. Abstracted from paper read before the So. African Assn. of Engrs. Describes the Witwatersrand gold-fields and the conditions to be met by winding plants, discussing the most advantageous method. 3000 w. Eng & Min Jour—Nov. 29, 1902. No. 52111.

Winding and Winding Appliances. Daniel Davies. Considers the varieties of winding engines, and their control, winding ropes, etc. 2200 w. Ir & Coal Trds Rev—Dec. 5, 1902. No. 52359 A.

**Methods.**

Mining Methods and Appliances. The first of a series of articles aiming to give information helpful to candidates for mine manager's examinations. Ill. 1100 w. Aust Min Stand—Nov. 6, 1902. Serial. 1st part. No. 52374 B.

**Mexico.**

The Mineral Zone of Santa Maria del Rio, San Luis Potosi. Jesus P. Menzano. Summary of a report made in 1890 for the Companie Investigadora Mexican y Americana. Gives the geology, mineral deposits, describing the ores found, etc. Silver, mercury, bismuth, iron, tin, etc., are found, but not all in payable quantities for mining. 2200 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 52283 D.

**Milling Plant.**

The Pride of the West M. & M. Co., Washington, Ariz. Jesse Scobey. An illustrated description of a milling plant and process where a complex ore, producing zinc, lead and copper, is treated in one milling operation that comprises dry crushing, roasting, magnetic separation, wet concentration, drying and smelting. 2200 w. Min & Sci Pr—Dec. 13, 1902. No. 52599.

**Mining Management.**

The General Management of Metalliferous Mines. Albert Williams, Jr. A discussion of the fundamental business principles upon which successful mining management depends. 2500 w. Engineering Magazine—January, 1903. No. 52488B.

**Muffle Furnace.**

A Wood-Burning Muffle Furnace. Louis Janin, Jr. Illustrated description of a large superimposed double muffle furnace for assaying, erected in Ely, Nevada. 600 w. Eng & Min Jour—Dec. 20, 1902. No. 52591.

**Quarrying.**

Improvements in the Methods of Quarrying Slate. Translated from *La Nature*. Describes the old methods and the new. Ill. 1300 w. Sci Am Sup—Dec. 6, 1902. No. 52220.

**Shaft-Sinking.**

The Sinking of Shafts in Water-Bearing Strata (Creusement de Puits à Niveau Plein). Marcel Tock. A detailed account of the sinking of two shafts in water-bearing strata at Quesnoy, Bois du Luc, Belgium. The Kind-Chandron process was employed. 8000 w. 6 plates. Rev Univ des Mines—Oct., 1902. No. 52443 G.

**Smelter.**

The New Smelter at Salida, Colorado. Etienne A. Ritter. An illustrated description of a large smelting works for treating lead and copper and other ores. 800 w. Eng & Min Jour—Dec. 20, 1902. No. 52592.

**Smelting.**

Use of Crude Oil in Smelting. A. von der Ropp. Read before the California Miners' Assn. A discussion of the practical side of the subject. 2300 w. Min & Sci Pr—Nov. 29, 1902. No. 52211.

**Surveying.**

The Evolution of Mine-Surveying Instruments. Continued discussion of the paper of Dunbar D. Scott, read at the Buffalo meeting, Oct., 1898. 1000 w. Trans Am Inst of Min Engrs—Nov., 1902. No. 52284 D.

**Tamps.**

Notes on Recent Experiments with Mechanical Tamps. W. R. Crane. An illustrated description of successful experiments in blasting, in which were used mechanical tamps consisting of a standard and two cylindrical wedges with serrated faces. 2500 w. Eng & Min Jour—Dec. 20, 1902. No. 52593.

**Timbering.**

Mine Timbering by the Square Set System at Rossland, B. C. A discussion of a previous article by Bernard MacDonald, by Ernest Woakes, at a meeting of the Canadian Mining Institute, and Mr. MacDonald's rejoinder. The conditions in a gold mine in Darien, Colombia, are described. 1800 w. Min & Sci Pr—Dec. 13, 1902. No. 52596.

Systematic Timbering in French Mines. Particulars from a report issued by a sub-committee of the Prussian Commission on the Falls of Rock and Coal in Mines, concerning the methods of working and timbering employed in French collieries. Ill. 900 w. Col Guard—Nov. 28, 1902. Serial. 1st part. No. 52193 A.

**Valuation.**

The Valuation of Mines of Definite Average Income. H. D. Hoskold. Suggests a method of valuing mines, pointing out certain financial features. 4000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 52285 D.

**Washington.**

Ore Deposits of Monte Cristo, Washington. An abstract monograph, by J. E. Spurr, published by the U. S. Geol. Survey. Ill. 2500 w. Mines & Min—Dec., 1902. No. 52197 C.

## MISCELLANY.

**Africa.**

The Distribution of Mineral Wealth in Africa (La Repartition et les Caractères de la Richesse Minérale en Afrique). L. De Launay. A general study of the mineral resources of Africa, with maps showing the distribution and possibilities of development. 6000 w. Rev Gen des Sciences—Nov. 30, 1902. No. 52436 D.

**Asphalt.**

The Asphalt Deposits of Pike County, Arkansas. C. W. Hayes. Describes those deposits which have been recently developed. 1500 w. Eng & Min Jour—Dec. 13, 1902. No. 52343.

**Manganese.**

The Manganese Industry of the Department of Panama, Republic of Colombia. E. G. Williams. Gives a general description of the region, the topography, deposits, character of the ore, the mines worked, etc. 11800 w. Trans Am Inst of Min Engrs—Nov., 1902. No. 52279 D.

**Ores.**

The Genesis of Ore-Deposits. J. Malcolm Maclaren. From the *Mining Journal*, London. An outline of the modern theory of ore deposition, as given in recent papers by American and German geologists. 5300 w. N Z Mines Rec—Nov. 17, 1902. No. 52610 B.

**Petroleum.**

American Petroleum Possibilities. George Ethelbert Walsh. An illustrated review of the oil regions of the United States and their productive capacity, with a forecast of their future, and a discussion of the growing importance of petroleum as fuel. 2000 w. Cassier's Mag—Dec., 1902. No. 52548 B.

**Shale.**

Shale Mine at La Harpe, Kansas. W. R. Crane. An illustrated article describing an instance of underground mining for brick making material. 2500 w. Mines & Min—Dec., 1902. No. 52201 C.

**Titanium.**

The Metallurgy of Titanium. Auguste J. Rossi. On methods of treatment of these ores and the alloys formed with them. 7200 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 52286 D.

**Zinc.**

Notes on the Magnetic Separation of Zinc-Iron Sulphides, with Observations on Preparatory Wet Concentration. Guy H. Elmore. Describes the treatment of lead-zinc-iron ores and the workings of the magnetic separator. Ill. 4000 w. Min Rept—Dec. 18, 1902. No. 52615.

## CONDUCTING TRANSPORTATION.

**Discipline.**

Efficient Discipline. Papers by C. H. Ketcham, W. W. Wheatly, G. W. Sengerland, and Thomas E. Mitten, discussing this subject from different points of view, with a general discussion following. 19000 w. N Y R R Club—Nov. 21, 1902. No. 52335.

## MOTIVE POWER AND EQUIPMENT.

**Brakes.**

Air Brakes. Illustrates and describes the air-brake apparatus, and principles of operation. 1700 w. Sci Am—Dec. 13, 1902. No. 52327.

Air Brake Testing Department of the Armour Car Lines. Illustrated description of the triple valve testing department, giving rules governing the cleaning and repairs of air brakes on the Armour car lines. 1000 w. Ry Mas Mech—Dec., 1902. No. 52205.

Automatic Outside Brake for Trains. A brief technical description of an interesting apparatus which has been tested at a speed of 62 miles an hour. Ill. 1200 w. U S Cons Repts, No. 1516—Dec. 10, 1902. No. 52235 D.

**Cars.**

The Latest Type of Passenger Cars in Great Britain. Brief illustrated description of cars built for the East Coast route between England and Scotland. 800 w. Ry Age—Dec. 5, 1902. No. 52209.

Two New Vanderbilt Cars. Illustrates and describes new designs for structural steel cars of 80,000 lbs. capacity. 500 w. Am Engr & R R Jour—Dec., 1902. No. 52115 C.

**Coal Weighing.**

The Time Element in Coal Consumption. Editorial discussion of the advantages of weighing coal instead of measuring it. 900 w. Loc Engng—Dec., 1902. No. 52226 C.

**Locomotive Practice.**

Modern Locomotive Practice. C. E. Wolff. Discusses the compound principle and how the special conditions under which a locomotive works affects the question. Ill. 2000 w. Mech Engr—Nov. 29, 1902. No. 52255 A.

**Locomotives.**

American "Prairie" Type Locomotives. Arthur E. Kyffin. An illustrated article discussing the special features of this class of engine. 2000 w. Prac Engr—Nov. 21, 1902. Serial. 1st part. No. 52062 A.

A Ride to Chicago and Back on the Locomotive of the Twentieth Century Limited. An interesting account of the trip, with illustrations. 2500 w. Sci Am—Dec. 13, 1902. No. 52320.

Atlantic Type Passenger Locomotive—Vandalia Line. Illustration, cross sections, rear and side elevations, with general dimensions. 5000 w. Ry Mas Mech—Dec., 1902. No. 52206.

Consolidation Engines for the Norwegian State Railway. Illustration and description of engines for service on heavy gradients. 1100 w. Engr, Lond—Nov. 28, 1902. No. 52186 A.

Consolidation Locomotive for the Baltimore and Ohio. Illustrations and general description. 400 w. R R Gaz—Dec. 5, 1902. No. 52224.

Engine No. 3—Wrexham, Mold, and Connah's Quay Railway. A rather unusual design with interesting features.. Illustrations and dimensions. 400 w. Engr, Lond—Nov. 21, 1902. No. 52080 A.

Fast Engines of the Atlantic Type for the Central Railroad of New Jersey. Illustrated detailed description. 800 w. Loc Engng—Dec., 1902. No. 52156 C.

Locomotive Types of Great Britain. J. F. Gairns. An illustrated review of all the types of British locomotives at present in use, old as well as new. 3000 w. Cassier's Mag—Dec., 1902. No. 52549 B.

Notes on the History of the American Locomotive. Herbert T. Walker. Reviews the history from 1802-3 of railroad engines, tracing in outline the development. Ill. 2500 w. Sci Am—Dec. 13, 1902. No. 52321.

Self Cleaning Locomotive Front Ends. Frank Slater. Diagrams and discussion of various types, with general discussion by members. 7800 w. W Ry Club—Nov. 18, 1902. No. 52337 C.

Some Features of British and American Express Locomotives. Paul T. Warner. Points out some of the general features in the design of the express passenger engines of the two countries. 2300 w. R R Gaz—Dec. 19, 1902. No. 52508.

The Compound Locomotive and Its Development in France. A. Herdner. An interesting review of types and advantages of each and the work for which each is suited, with discussion of their development in other countries and in France. Ill. 4500 w. Am Engr & R R Jour—Dec., 1902. Serial. 1st part. No. 52116 C.

Two-Cylinder Compound Locomotives. Illustrated description and dimensions of the most recent development of the two-cylinder compound for passenger service. It has a double-ported valve for the low-pressure cylinder. For use on the Canadian Pacific Ry. 3500 w. Am Engr & R R Jour—Dec., 1902. No. 52114 C.

**Locomotive Tests.**

Railway School Locomotive Tests. An illustrated description of the locomotive tests conducted each fall by the Railway School of Sibley College, Cornell, on the Delaware, Lackawanna and Western Railroad. 1200 w. Sibley Jour Mech Engng—Dec., 1902. No. 52585 C.

**Lubrication.**

Locomotive Lubrication. A very practical discussion on valves, cylinders and journals as well as lubricating oils, and their use, with illustrations. 6500 w. Pro Rocky Mountain Ry Club—Nov., 1902. No. 52537 D.

**Piston Valves.**

The Use of Piston Valves on Four-Cylinder Compound Locomotives (L'Emploi de Liroirs Cylindriques sur les Locomotives Compound à Quatre Cylinders). L. C. M. Pelletier. Data and results of the experience of the Eastern Railway of France, with details of construction of recent locomotives. 8000 w. 3 plates. Mem Soc Ing Civ de France—Sept., 1902. No. 52457 G.

## NEW PROJECTS.

**Africa.**

Railways in Africa (Die Eisenbahnen quer durch Afrika). Dr. Franz Ritter v. LeMonnier. A general discussion of transport in Africa with a review of existing and proposed railways. Two articles. 12,000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 14, 21, 1902. No. 52416 each B.

The Uganda Railway. The present article describes Mombasso, and the conditions found there; also Kilindini Station, Mazeras, and other stations, the country and some of the railway works. Ill. 2500 w. Engr, Lond—Nov. 21, 1902. Serial. 1st part. 52078 A.

**British Railways.**

The Railways in Parliament. Editorial review of the bills before the British parliament and the improvements proposed. 3000 w. Engng—Nov. 28, 1902. No. 52191 A.

**Cuba.**

The New Railroad System in Cuba. Illustrated description of the recently completed line between Santiago, on the east, and Santa Clara, in the centre of the island, with a through connection to Havana. 1600 w. R R Gaz—Nov. 28, 1902. No. 52040.

**Cut-Off.**

Construction Work on the Southern Pacific Cut-Off Across the Great Salt Lake, Utah. C. W. Arthur. An account of this interesting work, the diffiulcties met in the construction, etc. Ill. 1500 w. Eng News—Nov. 27, 1902. No. 52030.

**Japan.**

Progress of Japanese Railway Enterprise. Reviews briefly Japanese railway affairs. 1000 w. U S Cons Repts, No. 1512—Dec. 5, 1902. No. 52139 D.

**Long Island R. R.**

Methods of Work on the Atlantic Avenue Improvement of the Long Island R. R. Illustrated description of the subway and viaduct construction for removal of tracks from the surface of the street. 2200 w. Eng News—Dec. 18, 1902. No. 52-512.

## PERMANENT WAY AND FIXTURES.

**Coaling Station.**

Locomotive Coaling Station of the Wisconsin Central Ry. at Fond-du-Lac, Wisconsin. An illustrated description of a large coal storage and coal handling plant for supplying locomotives. 1100 w. Eng News—Nov. 27, 1902. No. 52029.

**Floods.**

See Civil Engineering, Rivers and Harbors.

**France.**

Some Notes on the Paris, Lyons and Mediterranean Railroad. General description, some of the locomotives and their performances, etc. 2200 w. R R Gaz—Dec. 12, 1902. No. 52353.

**Grade Crossings.**

The Abolition of Grade Crossings in Massachusetts. Edmund K. Turner. A report of what has been done in this state, legislation, and the course which has been pursued. Also general discussion. 15000 w. Jour Assn of Engng Soc's—Nov., 1902. No. 52507 C.

**Joints.**

The Chief Causes of Instability in Railway and Tramway Line Joints. A. Roberto Pullen. Discusses the difficulties due to joints in rails, and whether the joints are really objectionable, suggesting the adoption of some means of absolutely locking nuts on all lines. 1300 w. Tram & Ry Wld—Nov. 13, 1902. No. 52130 B.

**Passenger Stations.**

New Passenger Station of the D. L. & W., at Binghamton, N. Y. Illustrations, sections and plans with brief description. 500 w. Ry & Engng Rev—Dec. 6, 1902. No. 52261.

The New Passenger Stations in Dresden (Die Neuen Personenbahnhöfe in

Dresden). Josef Unger. With numerous illustrations of the new stations in Dresden, and plans of the buildings, track yards and connections. 2500 w. 4 plates. Zeitschr d Oesterr Ing u Arch Ver—Dec. 5, 1902. No. 52418 B.

The New York Central Terminal. Editorial on the plan for the improvement of the Grand Central Station in New York city. 1200 w. R R Gaz—Dec. 12, 1902. No. 52354.

**Shops.**

New Locomotive Repair Shops of the Philadelphia and Reading. Illustrated description of the shops and their equipment. 5200 w. R R Gaz—Dec. 12, 1902. No. 52352.

The Union Pacific Shops. Illustrated detailed description of the new shop plant at Omaha, Neb., which is rapidly occupying the site of the old shops. 4800 w. Ry Age—Dec. 12, 1902. No. 52389.

**Signalling.**

A New Railway Block Signal System. An illustrated detailed description of the Miller block signals which have just been placed in the Park avenue tunnel, New York. They are automatic and given directly in the engine cab. 4800 w. Eng News—Dec. 18, 1902. No. 52515.

The "Crewe" System of Electric Railway Signalling. Illustrated description of the system of working points and signals at this station on the London & North-Western Ry. 900 w. Engr, Lond—Dec. 5, 1902. No. 52369 A.

The "Crewe" System of Railway Signalling. Illustrated description of an electric system. 4800 w. Elec Rev, Lond—Nov. 28, 1902. No. 52182 A.

Railroad Signals. B. B. Adams. Illustrated description of block and interlocking signals. 2200 w. Sci Am—Dec. 13, 1902. No. 52323.

### TRAFFIC.

**Per Diem.**

Per Diem as a Standard of Measurement and Per Diem Rules as Practically Applied at St. Louis Terminals. W. M. Prall. Gives deductions from the applications of the per diem rules in the St. Louis and East St. Louis terminals. General discussion follows. 12000 w. St. Louis Ry Club—Nov. 14, 1902. No. 52083.

**Rate-Making.**

Rate-Making and its Causes. C. L. Wellington. A general discussion of the difficulties in making railroad tariffs and the influences which determine them. 1500 w. Pro Rocky Mountain Ry Club—Nov., 1902. No. 52538 D.

### MISCELLANY.

**Government Railroads.**

Railroad Building as a Mode of Warfare. John McAuley Palmer. Considers the civilizing effect of railroads, as an argument for urging a system of insular railways in the Philippines. 3200 w. N Am Rev—Dec., 1902. No. 52093 D.

**Methods.**

British and American Railroad Methods. Extract from a letter of an American mechanical engineer giving opinions, wherein British methods could be improved. 900 w. R R Gaz—Dec. 5, 1902. No. 52223.

**Oldest Railroad.**

The Oldest Railroad Company in the World. W. B. Paley. An account of the Plymouth and Dartmouth Railway, England, incorporated on July 2, 1819. 1600 w. R R Gaz—Dec. 19, 1902. No. 52510.

**United States.**

The Railroad System of the United States. An illustrated article showing the magnitude of the properties and operations. 1700 w. Sci Am—Dec. 13, 1902. No. 52322.

## STREET AND ELECTRIC RAILWAYS

**Australia.**

The Electric Railway in Sydney. An illustrated detailed description of the largest and most complete electric railway system in Australia. 3300 w. St. Ry Jour—Dec. 6, 1902. No. 52234 D.

**Benefit Association.**

The Brooklyn Rapid Transit Employees' Benefit Association. Some interesting features concerning its organization and methods of work. Ill. 2300 w. St Ry Jour—Dec. 13, 1902. No. 52307 D.

**Brakes.**

Pneumatic Brake Trials. An account of tests made of the Hewitt and Rhodes pneumatic slipper brake. 900 w. Elec Rev., Lond—Nov. 21, 1902. No. 52067 A.

**Earths.**

The Indication of Earths on Trolley Standards. Discusses faults on a trolley and the earth lamp system of indicating, and criticizing some devices on the market. 1500 w. Elec Rev, Lond—Nov. 28, 1902. No. 52180 A.

**Electric Branch.**

The Concord & Manchester Branch of the Boston & Maine Railroad. An illustrated description of an electric branch road built and operated by a steam railroad company. 2500 w. St Ry Jour—Dec. 6, 1902. No. 52233 D.

**Electric Locomotive.**

Electric Traction. Illustrated brief description of the 10,000-volt alternating-current locomotive for the Berlin-Zossen experiments. 1000 w. Sci Am—Dec. 13, 1902. No. 52325.

The Siemens & Halske High Speed Electric Locomotive (Schnellbahn-Lokomotive von Siemens & Halske A. G.) A detailed description of the electric locomotive built by Siemens & Halske for the high speed trials on the Marienfeld-Zossen line. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 15, 1902. No. 52403 D.

**Electric Railways.**

The Western Ohio Railway. D. W. Pell. Illustrated detailed description of a high-speed electric line operating at present 47 miles of road, and having 67.5 miles more under construction. 2000 w. Ry Age—Dec. 5, 1902. No. 52208.

**Electric Traction.**

Electricity as a Motive Power on Trunk Lines. Cornelius Vanderbilt. Considers, in a general way, the reasons pro and con, drawing conclusions from an examination of the principles involved. 3000 w. N Am Rev—Dec., 1902. No. 52090 D.

**Freight Handling.**

An Important Freight-Handling Road. An illustrated description of the methods adopted by the Toledo and Western Railway, an interurban line operating 68 miles of road. 2000 w. St Ry Jour—Nov. 29, 1902. No. 52101 D.

**Interurban.**

Collisions on Interurban Roads. Considers the causes of the accidents, and means of signalling employed. 1700 w. St Ry Jour—Dec. 6, 1902. No. 52232 D.

The Nogentais System, Paris, France. C. L. Durand. An illustrated description of an interurban traction system. 1600 w. Elec Rev, N Y—Dec. 13, 1902. No. 52332.

The Worcester & Southbridge Street Railway. An illustrated detailed description of this interurban line in Massachusetts, and its equipment. 4200 w. St Ry Jour—Dec. 6, 1902. No. 52227 D.

**London Underground.**

Deep-Tunnel Railways. Editorial discussing these London railways, especially the schemes associated with the name of Mr. Yerkes. 3000 w. Engng—Nov. 28, 1902. No. 52190 A.

London Underground Railways. A review of the London electric railway bills which will come before Parliament in 1903, with map. 1200 w. Elect'n, Lond—Dec. 12, 1902. No. 52529 A.

The Tangle of London Locomotion. Sidney Low. A discussion of the transit problem in London, the tube, or deep-level railways; the high-level, or sub-surface tunnels, etc.; the points the Special Commission should consider. 8500 w. Nineteenth Cent—Dec., 1902. No. 52371 D.

Underground Electric Tube Railways in London. A. Webster. Some gossip concerning old and new schemes, with sketch maps. 2400 w. Elec Rev, N Y—Dec. 20, 1902. No. 52527.

**Long Distance.**

Electric Traction on Long Distance Railways. Alton D. Adams. Reviews what has been done in Europe and America to solve this problem. 2000 w. Sci Am—Dec. 13, 1902. No. 52326.

**Mono-Rail.**

An Experimental Mono-Rail Line. Day Allen Willey. Brief illustrated description of a railway on the mono-rail system which has been in operation for experimental purposes near Baltimore. 700 w. Sci Am—Dec. 6, 1902. No. 52219.

The First Suspended Mountain Railway in the World (Die Erste Bergschwebebahn der Welt). E. A. Ziffer. A description of the suspended railway of the Langen type from Loschwitz to the heights of Lochwitz above Dresden. 2000 w. Mitt des Ver f die Ford d Local und Strassenbahnwesens—Nov., 1902. No. 52483 D.

The Manchester and Liverpool Electric Express Railway. Illustrated description of a proposed railway on the monorail system, to be operated at high speed by electricity. 5400 w. Tram & Ry Wld—Nov 13, 1902. No. 52125 B.

**New Jersey.**

The Electric Railroads in New Jersey. E. Bjerregaard. Map and account of the electric railroads of the state, especially those connecting New York and Philadelphia. Ill. 6500 w. R R Gaz—Nov. 28, 1902. No. 52039.

**New York.**

New York and Brooklyn Rapid Transit Subway. An illustrated article giving an idea of the location of the subway at the Battery and under the East River, and describing some of its features. This section is now under construction. 1400 w. Sci Am—Dec. 20, 1902. No. 52395.

New York Rapid Transit Railroad. Editorial review of the report of the Board of Rapid Transit Railroad Commissioners. 1800 w. Eng Rec—Nov. 29, 1902. No. 52117.

The Manhattan-Brooklyn Branch of the Rapid Transit Subway. Drawings showing interesting details of construction, with descriptive notes. 1200 w. Sci Am Sup—Dec. 20, 1902. No. 52399.

**Overhead.**

Some Notes on Overhead Tramway Wires. Lionel E. Harvey. Discusses the construction, inspection and use of the line. 1100 w. Elec Rev, Lond—Nov. 28, 1902. No. 52181 A.

**Pay Department.**

Pay Department of the Metropolitan Company's Construction Department. Describes the method in use in paying laborers where a large number are foreigners unable to speak English. 1200 w. St Ry Jour—Nov. 29, 1902. No. 52102 D.

**Power House.**

Some Features of the New York Rapid Transit Power House. Illustrations with brief description of interesting features. 1800 w. Power—Dec., 1902. No. 52266 C.

**Repair Shops.**

New Repair Shops of the Brooklyn Rapid Transit Company. Brief illustrated description of plans for convenient and extensive shops. 1000 w. St Ry Jour—Dec. 13, 1902. No. 52308 D.

**Rolling Stock.**

The Rolling Stock of the Manhattan Railway Company. Full particulars, illustrations and working drawings of the cars and trucks of the new electric equipment. 3500 w. St Ry Jour—Dec. 6, 1902. No. 52230 D.

**Single Phase Ry.**

Single Phase Railways. Discussion of paper by B. G. Lamme entitled "Washington, Baltimore and Annapolis Single Phase Railways." 10,000 w. Trans Am Inst of Elec Engrs—Nov, 1902. No. 52-289 D.

**Snow.**

Equipment and Organization for Properly Handling Snow Storms. J. F. Conway. Read at meeting of New England St. Ry. Club. Suggestions and directions. 4000 w. St Ry Jour—Nov. 29, 1902. No. 52103 D.

**Stray Currents.**

Electrolysis and Its Ravages. William Brophy. From a paper read before the International Assn. of Fire Engrs. Advises the placing of insulators or circuit breakers in metal pipes to prevent any flow of current over them. 2400 w. Fire & Water—Dec. 13, 1902. No. 52305.

Escaping Electricity and the Law. W. Valentine Ball. A review, from a British standpoint, of the legal aspects of the question of stray currents, and the liability for damages due to their electrolytic action and their interference with telegraph signals. 2500 w. Trac and Trans—Dec., 1902. No. 52562 E.

**Surface-Contact.**

Surface-Contact Systems. Abstract of a paper by G. Paul, of Nuremberg. A criticism of some of the systems. 1400 w. Engng—Nov. 21, 1902. No. 52073 A.

**Third Rail.**

The Sleet Break-Down of the Manhattan System. An article showing that the recent difficulties in running trains on the New York Elevated Ry. are not inherent in the third rail system, and giving illustrations of pneumatic sleet cleaner and contact shoe and hanger. 800 w. Elec Wld & Engr—Dec. 20, 1902. No. 52518.

Third Rail Electric Traction in Italy. Illustrated description of interesting features of the line between Porto Ceresis and Milan, especially the steam plain. 1500 w. St Ry Jour—Dec. 6, 1902. No. 52228 D.

**Traction Engines.**

Tramway Traction Engines for Glasgow. Drawing and descriptive notes of the 800 h. p. engines which have done admirable service in connection with these tramways. 600 w. Engr, Lond—Dec. 5, 1902. No. 52368 A.

**Tramways.**

Electric Tramways. C. Hopkinson, B. Hopkinson and E. Talbot. Read before the Brit. Inst. of Civ. Engrs. Abstract. Considers briefly the generation of power, transmission of power to the cars, rolling stock, and earth returns. 1700 w. Mech Engr—Nov. 22, 1902. No. 52059 A.

**Transfers.**

Some Disputed Points Concerning Transfers. Arthur Wentworth. A discussion of the views of C. D. Meneely as given in a recent paper. 2500 w. St Ry Jour—Dec. 6, 1902. No. 52231 D.

**Tyneside.**

Electric Traction on Tyneside. Illustrated description of the line and its equipment. 3000 w. Tram & Ry Wld—Nov. 13, 1902. No. 52126 B.

**Rail Welding.**

Expansion and Contraction of Welded Tramway Rails. C. V. Boys. An explanation of the action that takes place. 1100 w. Tram & Ry Wld—Nov. 13, 1902. No. 52128 B.

Thermit Welding for Tram Rails. C. E. Masterman. Describes the thermit process and how it is carried out in practice. Ill. 1900 w. Tram & Ry Wld—Nov. 13, 1902. No. 52127 B.

**Wheels.**

Street Railway Wheels in Europe. Illustrated descriptions of wheels used and facts relating to their wear, cost, etc. 2200 w. St Ry Jour—Dec. 6, 1902. No. 52229 D.

# EXPLANATORY NOTE—THE ENGINEERING INDEX.

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## THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist & Metallurgist. *m.* London.

Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

# CURRENT RECORD OF NEW BOOKS

Note—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* The Engineering Magazine.

**Annual Review.**

L'Année Technique (1901-1902). By A. da Cunha. Size, 11 by 7¼ in.; pp. IV, 271; illustration, 114. Price, paper covers, 3 fr. 50c. ($1.05). Paris: Librairie Gauthier-Villars.

Under the above title, the author gives a general review of industrial and scientific progress in engineering and architecture during parts of the years 1901 and 1902. A great variety of subjects is treated, under the general heads of tramways and traction; cycles and automobiles; public works and architecture; maritime and naval structures and ordnance; and aerial navigation. Among the special objects described are some of the latest types of electric railways; trolley automobiles; suspended railways; movable stations; new types of motor vehicles; ferry bridges; bascule bridges; lighthouses; submarine boats; turbine steamers; life-saving floats; air ships and balloons. These and many other matters of interest to the engineer are well illustrated and described, and the book makes a very readable record of engineering progress.

**Cyclopedia.**

Universal Cyclopedia and Atlas. Charles Kendall Adams, LL.D., Editor-in-Chief. Rossiter Johnson, Ph. D., LL. D., Editor of Revision. Size, 11 by 8 in.; 13 volumes, including index volume. Colored plans and maps, plates and engravings. Price, cloth, $72. New York: D. Appleton and Company.

On its first appearance, in 1874, this work was known as Johnson's Universal Cyclopedia. Since then it has been revised several times, important articles have been rewritten and new ones added, many of them by leading specialists. The present edition has been issued under the direction of President Adams and Dr. Johnson, assisted by a large staff of associate editors, contributors and revisers. This cyclopedia is too well known to need any description, and its merits are too well acknowledged to need any commendation. The march of events is so rapid nowadays that it is extremely difficult for any work of reference to keep up-to-date, but, on the whole, this has been very well done here, and some of the latest information is embodied in appendices, at the end of each volume. Under the head of Electric Motor, the Lauffen-Frankfort power transmission, in 1891, which is rather ancient history, is given as an example of long-distance transmission, and in the same paragraph, a typographical error, several times repeated, makes "Drehstrom," or rotary current, masquerade under the name of "Orehstrom." On the other hand, however, the map of Africa, besides giving all the latest known geographical features, shows the new political divisions which have resulted from the South African war, and altogether, the high reputation of this work has been well preserved.

**Electrical Engineering.**

The Elements of Electrical Engineering. A First Year's Course for Students. By Tyson Sewell, A. I. E. E. Size, 8 by 5½ in.; pp. 332; figures, 204. Price, $3. New York: D. Van Nostrand Company. London: Crosby, Lockwood and Son.

This book, by the assistant lecturer and demonstrator in electrical engineering at the Polytechnic, Regent Street, London, is based upon courses of lectures given by him to students desirous of qualifying as electrical engineers, and the subject matter has been treated, as far as possible, on easy and non-mathematical lines. After the introductory portions, there are chapters on the heating and magnetic effects of the electric current, the magnetisation of iron, primary batteries, accumulators, indicating instruments, electricity-supply meters, measuring instruments, electrical measurements, are lamps, incandescent lamps and photometry, the continuous-current dynamo, and direct-current motors. The wide field here indicated is well covered, and the book should prove very acceptable to those for whom it is primarily intended, namely, students who have only a limited time for study and who are attending evening and other courses of instruction at polytechnic and technical schools.

**Electricity.**

The How and Why of Electricity. A Book of Information for Non-Technical Readers. By Charles Tripler Child. Size, 7¾ by 5¼ in.; pp. 127; figures, 40. Price, $1. New York: Electrical Review Publishing Co.

The author of this book had a wide experience in electrical work, and at the time of his death, he was the technical editor of the *Electrical Review*, of New York. Besides having a thorough knowledge of electricity, both in its theoretical and practical aspects, he possessed that far rarer gift: the power of expressing his knowledge so lucidly and plainly that he could be understanded of the people as well as by the trained technical man. The enormous increase in the applications of electricity, of late, has made it inevitable that the average man should be brought into more or less intimate contact with various kinds of electrical apparatus, and it seems natural that he would desire to know something about the machines and instruments he handles or sees in operation all about him, and through whose agency he is enabled to live the modern life. The purpose of this little book is to give the non-technical man just this information, and it tells in clear and simple language, aided by appropriate illustrations, how electricity is generated, handled, controlled, measured and set to work, and how familiar electrical apparatus operates. It is understood that the proceeds of the sale of this book will, to a large extent, be paid to the widow and children of the author.

**Engineering.**

Ancient and Modern Engineering and the Isthmian Canal. By William H. Burr, C. E. Size, 9¼ by 6½ in.; pp. XV, 473; profusely illustrated with half-tones, plans and diagrams. Price, $3.50; postage, 27 cents additional. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Columbia University, where the author is the professor of civil engineering, in the course of its university extension work has provided for lectures to the people of New York, and this book is the outcome of a series of six lectures delivered at the Cooper Union, the substance of which addresses has been suitably expanded for the purposes of publication. The book is divided into six main parts: Ancient civil-engineering works; bridges; water-works for cities and towns; railroad engineering; the Nicaragua route for a ship canal; and the Panama route. The lectures, as originally delivered, were of a more or less popular character, but the book while preserving the easy style of the addresses, which makes it both pleasant and interesting to read, has become more technical in substance, particularly in the section devoted to bridges, which is the author's specialty. The parts which are, perhaps, of the greatest present interest, are those on the two principal competing routes for the Isthmian Canal, the Panama and the Nicaragua. The author, as a member of the Isthmian Canal Commission, has made personal examinations of both these routes and therefore speaks with the fullest knowledge of his subject. Not only these parts, however, but the whole book presents a body of interesting technical information of the highest practical value, in an agreeable and attractive manner.

**Engineering Education.**

Society for the Promotion of Engineering Education. Proceedings of the Tenth Annual Meeting Held in Pittsburg, June, 1902. Volume X, and Index, Vols. I-X. Edited by Robert Fletcher, Calvin M. Woodward and Clarence A. Waldo. Size, 9 by 6 in.; pp. XXXII, 300. Price, $2.50. New York: Engineering News Publishing Co.

The papers and discussions forming the principal part of this book cover a wide range of topics relating to engineering education and to education in general, and besides the record of the proceedings, there are included in this volume lists of members of the Society, the constitution, and memoirs of deceased members. Among the latter is an appreciative notice of Prof. J. B. Johnson, late dean of the College of Engineering of the University of Wisconsin, whose portrait also forms the frontispiece of the book, and who was the founder of The Engineering Index. There are two unique features of the present volume: One is the statistical report on the present status of engineering education in the United States, Canada, Australia and England, with tables showing the number of students in the various departments and classes of the engineering colleges. The other special feature is the combined index of the first ten annual volumes of the Society, now making available what is probably the largest and most important single collection of essays and discussions in the English language on the subject of engineering education.

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## BOOKS ANNOUNCED.

Locomotives: Simple, Compound, and Electric. 4th edition. By H. C. Reagan. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Steam Turbine. By Robert M. Neilson. Price, $2.50 (7s. 6d.). London, New York and Bombay: Longmans, Green, & Co.

Economics of Forestry. By Bernhard E. Fernow, LL. D. Price, $1.65. New York: Thomas Y. Crowell & Co.

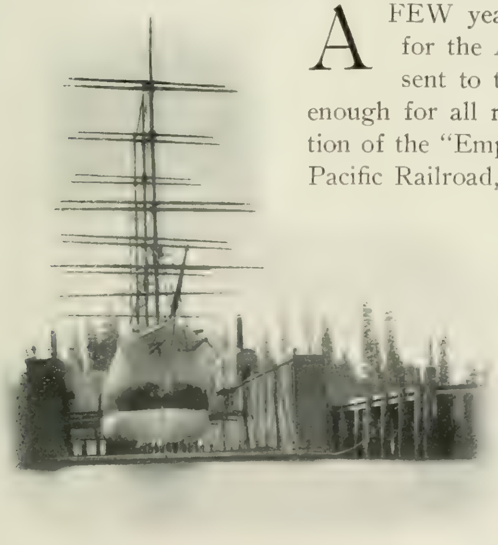
THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXIV. MARCH, 1903. No. 6.

# AMERICAN OVERLAND TRANSPORT TO THE ORIENT.

*By Harrington Emerson.*

Mr. Emerson does not treat his theme from the limited viewpoint of the rivalry of competing routes or ports, but from that of a current change in one of the great world tides of traffic. In this light it has universal interest and importance.—THE EDITORS.



A FEW years ago, steamers no longer fit for the Atlantic or Indian service were sent to the Pacific as being quite good enough for all requirements. With the exception of the "Empresses," built for the Canadian Pacific Railroad, there was not, until the Spanish-American war, a first-class steamer on the American Pacific. Now, the largest steamers ever constructed in American waters and with one exception, the Cedric, the largest steamers ever built, have been ordered for the Pacific Ocean traffic.

What has brought about the change? Why is it that San Francisco and Puget Sound, Honolulu, and even distant Nome, see in their roadsteads, not some, but many, of the largest ocean craft afloat? What is the cause and what is the future of this new movement? It has long been known that Western Asia is densely populated and that an enormous Asiatic trade exists, now going to Europe and America by

THE GOLDEN GATE. ENTRANCE TO THE HARBOR OF SAN FRANCISCO.

way of the Suez canal. It has long been known that Tokyo, Kobé, Shanghai, Hongkong, are nearer to San Francisco than to London and Hamburg; yet in spite of the development of Japanese import and export trade, in spite of the growth of trade relations with the Philippine Islands since their annexation to the United States, the greatest part of the carrying trade even from and to New York goes by way of Europe.

The reason is obvious. The Pacific Coast States are not as yet a manufacturing region. They are largely importers of eastern manufactured goods. Their own exports are raw materials, and with the exception of flour not such as the Orient demands.

Exports to the Orient must come from the eastern and southern States—railroad iron and other equipment, mining machinery, tobacco and cotton—and for these goods the usual railroad rate across the continent is prohibitive, as it costs almost twice as much to send boxed goods from New York to San Francisco as from New York to London, and thence by steamer direct to Puget Sound via the Suez canal, the Straits, Hongkong and Yokohama. The average railroad rate across the American continent in carload lots is $15 a ton; the rate on similar goods from London to Seattle is $10 a ton; and one of the chief obstacles to a lowering of the railroad rate through ocean competition is the requirement that American goods may not be shipped from an American port to an American port except in American bottoms. Before there could be any hope of a large increase in Pacific Coast exports and imports, the whole railroad situation had to be changed; and this is what has happened.

PANORAMA OF SAN FRANCISCO FROM TELEGRAPH HILL.

The settlement of the Pacific Coast dates from the discovery of gold in California. Between 1849 and 1873, the date of the completion of the first Pacific railroad, $1,200,000,000 in gold were taken from California mines and nearly $400,000,000 in gold and silver from the Nevada mines. There was no possibility of freight traffic between California and the rest of the United States except by sea, and as New York was as far away as London, as the war-inflated prices of the eastern States were still above those of Europe, California's imports of mining machinery and other manufactured supplies came largely from England. There was nothing for the ships to take back, until a very low rate was made on wheat exports when wheat raising in California began to assume importance, especially as wheat was worth over $1 a bushel. The early trade of California was distinctly of a maritime character, with steamer lines to Panama, to Hawaii, even to China and Japan, with many coasting lines, south to San Diego and north to Portland and Puget Sound. San Francisco was easily the queen city of western America, and not only on account of the great wealth and equally great enterprise of the Californians, but because it was the only western city, it became the terminus of the first Pacific Railroad, built in an era when roads were constructed to enrich the promoters and not to make money out of operation. Of such a road the old Kansas Pacific was a good example. It was built through an unsettled country, receiving an enormous land grant; elementary dictates of common sense were neglected in its location, the road abounding in useless grades and cuts; and until reorganized, it never paid. The early Pacific roads were handicapped by unfortunate and often wholly unnecessary location over high mountain ranges, and this will forever add to their cost of operation compared to roads which have much lower grades or wholly escape mountain divisions, as will be the case with the Grand Trunk extension to the Pacific.

On the old Pacific Road, now so differently managed, there was one determining factor, namely, the competition from sailing vessels around Cape Horn. No attempt was made to develop local traffic. The hay rate from western Nebraska to western Wyoming was $900 a car, and emigrant passenger rates from Omaha to San Francisco as high as from New York to California by way of Panama. The emigrant coach was attached to a freight train running on a schedule of 11 miles an hour, and for twenty years after the opening of the rail-

COAL BUNKERS, SEATTLE.

THE TACOMA WATERFRONT.

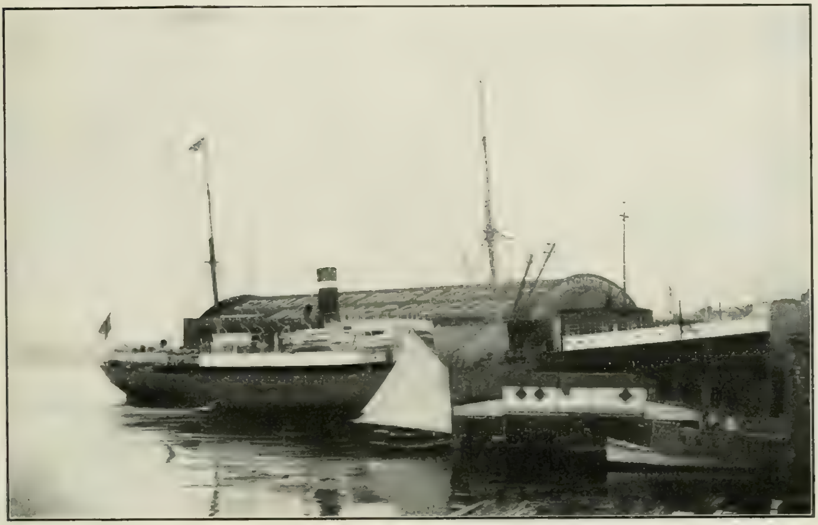
road, the territory of Wyoming, equal in area to New York and Pennsylvania combined, and with great natural resources that the railroad should have developed, was able to give homes to no more than 60,000 people. Mr. Huntington imagined that by occupying the narrowest part of the United States between the Atlantic and Pacific he would always be able to control the trans-American traffic, little foreseeing that a constructive instead of monopolistic policy would be able to carry cotton from Texas to Puget Sound at a cheaper rate than his road could carry it from Galveston to San Diego. The era of monopoly ended with the construction of competing lines to the Pacific Coast, which have resulted not only in the substitution of American manufactures for British in California, but also in the development of the California fruit trade. The Pacific Mail, aided by a subsidy for the mails, maintained freight and passenger relations between Hawaii and the United States and relied for a large part of its income on the Chinese coolie trade, first to California and then to Hawaii; but it brought also silks, tea, and curios, thus making a beginning of a Pacific and Oriental traffic and trade.

In the meantime the bonanza wheat farms of North Dakota had stimulated railroad building in that prairie region, and aided by the largest railroad land grant ever given, about 80,000 square miles, one of these roads pushed through to the Pacific, making its terminus at

THE DRYDOCK, PUGET SOUND NAVY YARD.

Tacoma, on Puget Sound, which is by far the best harbor on the Pacific Coast. This was still in the era of speculative railroad building, and it is not unfair to say that the Northern Pacific was built not for the sake of any traffic immediately in sight, but to capture the land grant. The Canadian Pacific, from Montreal to Vancouver, paralleling the Northern Pacific at a distance of 300 miles and playing on the idea of international rivalry, was also built by grants and subsidies, and it became a competitor of the first importance, because, being subsidized and wholly beyond American control and largely beyond American pooling arrangements, with its terminal boat service it could and did reach every American Pacific Coast city, and made strong bids for a share of the traffic.

There was, however, a stronger force yet to change the future, and one that distinctly inaugurated a new era. The Great Northern Railroad, a wheat road of Minnesota and North Dakota, had been developed and made by one man, Mr. James J. Hill, who, living on the line of his roads, from the very first built not for the sake of bonds or subsidies, but for the immediate and prospective traffic. Having made a great success of prairie roads, just when speculative building in American roads had ended, Mr. Hill began to reach out toward the Pacific and completed his through line in the darkest days of financial and industrial depression, but when steel and labor were at their lowest. The project was ridiculed by those whose standards belonged in the past. Mr. Hill neither asked for nor received a subsidy, but built his road as a simple business undertaking. It was built so well, and withal so cheaply, that he made the boast that he could pay all fixed charges at a freight rate which would not pay operating charges on the extravagantly constructed subsidized lines of the earlier period. He was the first to apprehend that the State of Washington had the most gigantic lumber resources in the world, that one acre of Washington timber will furnish in its lumber as many car loads of freight as 120 years of wheat product from a Dakota farm, and that this lumber, unique in its dimensions and cheapness, was needed not only among the prairie



IN THE ALASKAN TRADE, SEATTLE.

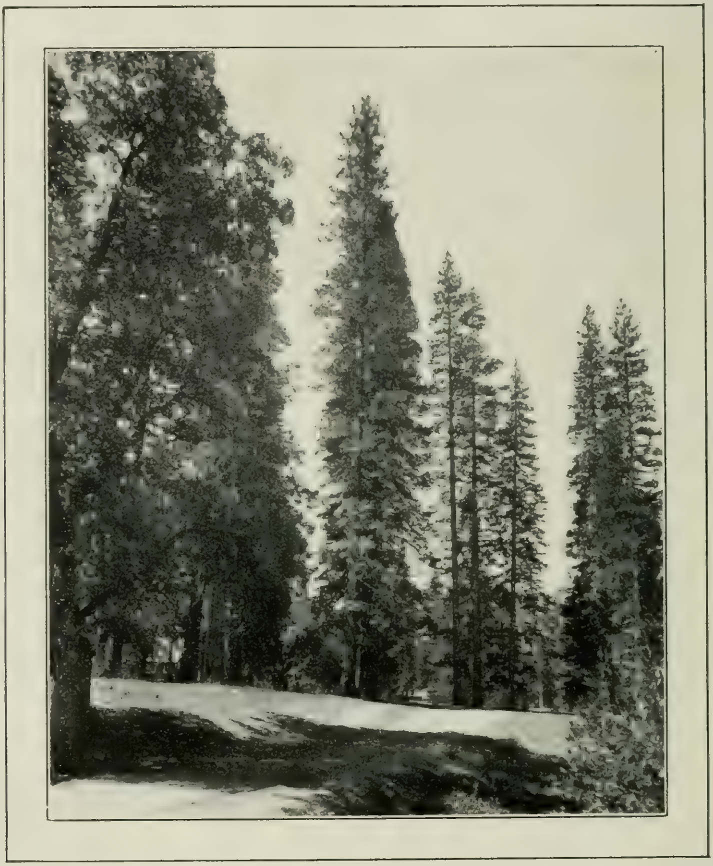
GREAT NORTHERN DOCKS, SEATTLE. LOADING WHEAT FOR EUROPE AND COTTON FOR JAPAN.

GRAIN ELEVATORS AT TACOMA.

farmers but all over the United States. All other transcontinental railroads had been constructed with an eye to west-bound traffic. Mr. Hill's road was built for east-bound traffic. The wheat cars, filled to overflowing at the crop-moving seasons of the year and then standing idle on side tracks of Dakota, could be utilized all the year through to carry Washington lumber eastward.

PORT BLAKELY MILLS—THE LARGEST LUMBER MILLS IN THE WORLD.

The terminus of his road was Seattle, also on Puget Sound, and also with great natural terminal facilities. The "Empress Line" from the terminus of the Canadian Pacific at Vancouver had become the fastest and best-patronized line across the Pacific. At Vancouver were unlimited supplies of good coal at very low price, and the route to Yokohama, Hongkong, and India is over a thousand miles shorter than the first established route via Hawaii. Seattle and Tacoma have at their back doors coal fields more extensive than those of Vancouver. These two cities are as near to the Orient as the Canadian Pacific terminus, so Mr. Hill, feeling sure that he could divert a part at least of the tea and silk trade to his own railroad line, early formed an alliance with the greatest of Japanese lines—the Nippon Yusen Kaisha, a line in ocean tonnage ranking among the foremost in the world, adding the factor of the very low cost of operation of steamers under Japanese control to the other advantages of cheap coal and short route. This was at a competitive period when he regarded the other continental lines as rivals; and as an example of what could be done the Great Northern actually invaded the Southern California fruit regions, brought fresh fruit by steamer to Seattle, and sent it in the cool northern spring to Chicago, making shorter time than by the southern roads. Owing to the development of the Washington lumber industry, the traffic east-bound much exceeds the west-bound freight, so, on an actual count recently made, nearly five times as many loaded cars are moving east as going west. It became plain that as the northern roads, all of them, earned dividends in the prairie regions from their grain traffic and paid all the expenses of western operation by the east-bound lumber traffic (thus reversing the conditions that had prevailed for all the southern roads) it would be possible to carry



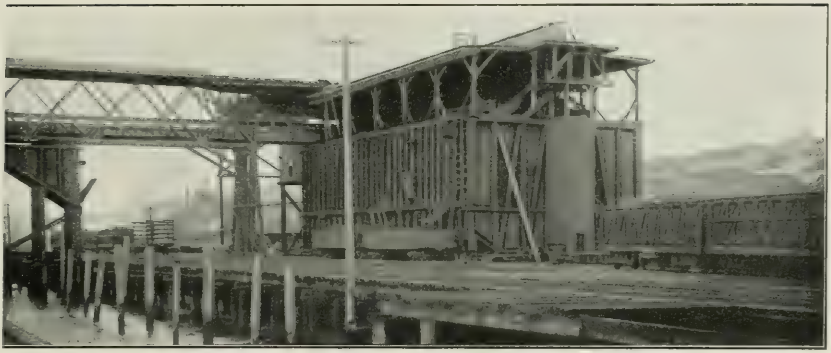
YELLOW PINES 225 FEET HIGH IN A CALIFORNIA FOREST.

LAUNCH OF A SCHOONER AT MORAN'S SHIP-YARD.

HOISTING 60-TON BOILERS INTO THE S. S. CITY OF PUEBLA, SHIP-YARDS OF MORAN BROS. CO., SEATTLE.

ROSLYN COAL WHARVES, SEATTLE.

west-bound freight at nominal rates—any rate above the cost of handling and the slight increase in expense of hauling full cars instead of empties. With the establishment of the Nippon Yusen Kaisha line, which fortunately occurred when the price of wheat and flour was at its lowest, the Oriental trade began to assume large dimensions, the steamers going out with full Orient-bound cargoes, but bringing back comparatively little. It was during this same period that a great number of Japanese cotton mills were started, the cotton being imported from the United States by way of London and Hamburg. All the conditions were now favorable for a revolutionary move of world-wide importance. The Northern Pacific paralleled the Great Northern; both started at St. Paul and both reached Seattle; both had many branch lines in the grain fields of Dakota; both ran through the richest lumber forests of Washington. The Burlington, a corn road, reaching St. Louis, was an ally of the Northern Pacific, having effected a junction with that road at Billings, Montana, yet with rumors of its own extension to the coast. It was the part of wisdom to utilize existing roads to the fullest rather than to build new ones, to combine the two roads that paralleled each other and had absolutely identical interests, and to control the "Burlington" which at once afforded a direct outlet for Washington lumber to all the treeless central states, eight or nine in number, and also with terminals at St. Louis, directly connecting it with many of the southern cotton roads. Therefore with dramatic unexpectedness the Northern Securities Company was formed, identifying these three roads, with the deliberate intention of diverting the cotton exports of the United States to Asia by way of Atlantic and European ports to the ports of Puget Sound. The temporary and apparent rivalry between the combination of the northern and of the southern roads was but an episode. It is not a question as to whether



ROSLYN COAL WHARVES, SEATTLE.

Puget Sound ports shall not be favored in transcontinental rates compared to San Francisco, or whether the Great Northern shall carry fruit from Southern California to Chicago, but whether the unlimited trade of eastern Asia shall pass to Europe by Pacific American steamers and American railroads, or continue to go by way of the Suez canal.

From its first building and down to the present time, the Panama Railroad has been able to compete with the all-ocean route in handling freight between the Pacific and the Atlantic coasts. The European mails and passengers already go from London to eastern Asia by way of Canada, because it is shorter and there is a saving of ten days in time. The limits imposed on cheap freight traffic from Europe to Asia are:—

1.—The tolls through the Suez Canal.

2.—The size of ships that can pass the Suez Canal.

3.—The cost of coal along the route.

4.—The distance.

Tolls may be abolished, but this is not likely; it will take years to deepen the canal even if this project should be advocated; the cost of coal along the route, as well as the distance, will always be a drawback. The only limit to the size of ships that can be put on the Atlantic is the depth of the harbors on both sides.* This limit does not exist in the Pacific, where Puget Sound has 400 to 500 feet of water within a cable's length of the shore. There is abundant and cheap coal in Great Britain, on the Atlantic seaboard, on Puget Sound, and all along the line of the northern roads, and there are an unlimited number of empty freight cars west-bound. By building the largest ships in the world, even though they run under the more expensive

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* Mr. Robinson's article following deals with the engineering aspects of the very important work of enlarging this limit by deepening the harbors.

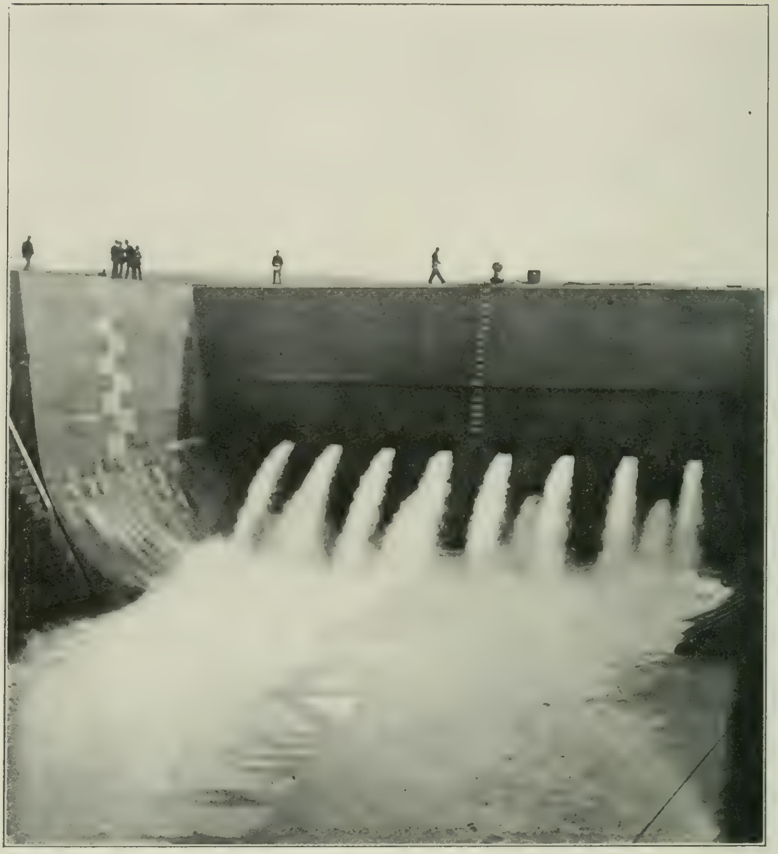
Interior of new wheat warehouse, Tacoma.

Portable conveying machinery unloading tea, Tacoma wharves.

PHASES OF AMERICAN TRANS-PACIFIC TRADE TO THE ORIENT.

S. S. OREGON IN FLOATING DRYDOCK, MORAN BROTHERS COMPANY, SEATTLE.

American register, by filling the west-bound cars at a rate litttle more than the cost of handling, Mr. Hill knows that he can turn the export trade with western Asia from its three-hundred-year old way past India to the direct Pacific sea route past Alaska. Before these new ships were ordered, experts were sent to Scotland, Ireland, and Germany, to absorb all that could be learned of modern mammoth ship building; and to escape from all hampering traditions of the past, an entirely new company, the Eastern Shipbuilding Company, was formed to construct



FLOODING THE DRY DOCK, PUGET SOUND NAVY YARD.

them and took the contract before even the site was purchased on which the new yards were to be established. These steamers are 630 feet long, 73 feet wide, and on draught of 36.5 feet will have displacement of 37,000 tons. The navigating deck is 90 feet above the keel. Each steamer can carry 1,200 troops, and the cargo capacity exceeds 20,000 tons. Some of the hatches are large enough to admit a complete locomotive. With a horse power of 11,000, a speed of 14 knots will be maintained. To accommodate these steamers enormous docks and warehouses are being constructed at Seattle, both wharves and warehouses of gigantic size already existing at Tacoma. Cotton baled by the Lowry compress weighs 45 pounds to 50 pounds to the cubic foot, and 400 to 500 large freight cars loaded with these bales will furnish cargo for one only such steamer. The total cotton exported in 1900 was 1,500,000 tons, much of it to Europe for direct or manufactured export to the millions of Asia. These have now made a notable beginning in the manufacture of their own cotton cloths, and increasing quantities of American cotton will be sent direct to them.

Before these ships are launched, in connection with the Boston Steamship Company—which operates the Shawmut and Tremont, twin-screw steamers of 9,600 tons and 15-knot speed, and also the three smaller steamers, Hyades, Pleides, and Lyra—the northern railroads have quoted a rate of $8 a ton for the transport of Government supplies from Chicago to the Philippine Islands, of which the railroad share is $3.75 per ton. Return rates have been quoted on wool from Australia and New Zealand which make it probable that the imports from British Australasia to Boston, New York, and Philadelphia will come by the Pacific overland route instead of through Suez.

There are few more striking facts than the growing importance of the Puget Sound customs districts. In the year that has just closed all the customs districts of the United States showed a decline of exports of grain and grain products except the Pacific Coast ports, the shipments from the Sound increasing 45 per cent.

S. S. WILLAMETTE ON MARINE WAYS, MORAN BROS. COMPANY'S SHIP-YARD, SEATTLE.

From an American point of view there is one shadow in this bright light of future American supremacy on the Pacific, and that is the rivalry of the Canadian roads to the north. One of these already in full operation, the Canadian Pacific, runs from ocean to ocean. The other, the Grand Trunk, is now building to Port Simpson, the most northern seaport in British Columbia. Both these roads command rich wheat belts; both of them tap exceedingly rich and very good coal fields; both of them as they approach the Pacific Coast pass through timber lands of the same general character as the heavy forests of Washington and Oregon. The Grand Trunk will have six advantages over all its American competitors. It will stretch from Atlantic to Pacific under one management and can make its own through rates, while none of the American roads extends further than Chicago, and it will further control ocean-steamer connections at both ends; it will be the latest built road, with latest and most consistent equipment; its Pacific terminus, Port Simpson, a magnificent harbor on the Alaskan border, is nearer by 500 miles to Asia than is Puget Sound or Vancouver, yet the road itself is as short as any other transcontinental line; it escapes entirely the climb and heavy grades over the Rocky Mountains, which do not extend as far north as its line; its wheat belt extends from Manitoba unbrokenly to a region that is west of Vancouver, a gain in local agricultural lands of nearly 1,000 miles over the American lines; and it will by the location of its terminus monopolize the whole of the enormous and rapidly growing Alaskan traffic.

PACIFIC COAST S. S. COMPANY'S STEAMERS AT THE SEATTLE WATERFRONT.

Great and serious as this competition will eventually prove, several years must elapse before it is felt, and this respite should be utilized by the American roads to build up local, through, and international traffic, so that an ever decreasing freight rate will, through an ever increasing tonnage, augment the total receipts. Also new economies of intensive operation, as yet almost untried in railroading although successful in other modern industries, can at least double the present efficiency and per dollar of fixed charges carry twice as much freight, without lowering wages or adding to cost. Roads so managed and so developed will need to fear no rival, whether it be a deepened and toll-free Suez Canal, a Panama Canal, a modern railroad at Tehuantepec, or one great wheat farm from Winnipeg to Fort Graham.

PUGET SOUND PASSENGER STEAMERS AT THE SEATTLE WATERFRONT.

The heavy capitalization and the merger of the northern roads will in the end prove advantageous, not only to them but in far greater degree to all the people of the United States, as it will necessitate the development of every local resource, and also bring about a diversion of the world's Oriental trade from the Atlantic to the Pacific, from European to American control, and thus quicken into being a thousand industries not yet conceived.

To this beneficent stimulus all the country will respond, most of all the younger commonwealths of the Pacific Coast, with their flourishing seaboard cities each with its own particular advantages of location and environment. San Francisco will long remain the queen city of the west. Not only has she the lead over all rivals in age and accumulated wealth, but she is the central city, with innumerable tributary manufacturing establishments, with local steamer lines running southward to Panama, northward to Alaska, westward to Hawaii, already

U. S. S. WISCONSIN IN DRYDOCK AT PUGET SOUND NAVY YARD.

connected by the only trans-Pacific cable. San Diego is the nearest of all Pacific cities to Panama, nearest also to the Atlantic waters, nearest to Samoa, Australia, and New Zealand. Portland, the Philadelphia of the west, a terminus for both the great combinations of the railroads, the northern and southern trans-American lines, will have a double opportunity for future growth. Seattle and Tacoma, with world interests that are identical, are nearest to Alaska, Japan, and the Philippine Islands, have the best harbor in the world, and unlimited coal resources. There will be business and to spare for all of them.

# MODERN MACHINERY FOR EXCAVATING AND DREDGING.

*By A. W. Robinson.*

We have more than once quoted the dictum that the only limit to feasibility in engineering work is the cost of execution. This limit the genius of the engineer is constantly pushing farther and farther away—very strikingly in the field of work with which Mr. Robinson deals. The huge tools he discusses are those by which the engineer reshapes not only the seas and the hills, but the very flow of commerce and civilisation. They are the mechanical elements in so vast and wide-reaching undertakings as the Panama Canal, or the land routes reviewed by Mr. Emerson in the preceding paper. And their general influence on the economy of transport and distribution of wealth are brought out by Mr. Robinson in his opening paragraphs. The present article deals more particularly with machines for cutting the roadways of internal transportation. A second will take up the heavier types more closely adapted to harbor and ocean waterways.—THE EDITORS.

IT is recognized by thoughtful people that commercial supremacy is obtained and held by that nation which has the best developed and most economical transportation, both internal and with other nations. What is true of nations in this respect is true also of local communities, in so far as their advancement and well-being are promoted by facility of interchange. The development of the channels of trade now occupies a large share of public attention and no question is more important or more vitally affects commercial prosperity than does transportation.

It is proposed in this paper to describe some of the modern mechanical methods by which the pathways of transportation by sea and land are made, and to show what great possibilities are in store in the immediate future, when the development that is now going on shall have become further advanced.

The fact that increased economy is obtained by increased size and capacity has caused a wonderful advance both in the size and power of water-borne vessels, and in the rolling stock of railways. The same cause has operated to bring about a rapid growth in the power and

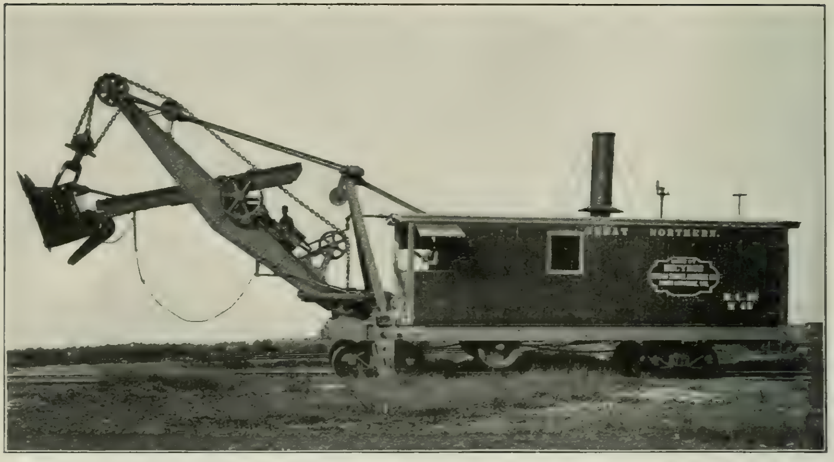


FIG. I. RAILWAY STEAM SHOVEL, DIPPER $2\frac{1}{2}$ YARDS CAPACITY.

The Bucyrus Company, South Milwaukee, Wis.

capacity of dredges and steam shovels. In ten years the paying load carried by a representative ocean cargo steamer, and by a representative freight train, has about doubled, and a similar rate of increase is observed in the capacity of dredges and steam shovels. It is safe to say that this growth will continue, limited only by the conditions of each case. The limiting condition in the size of steamships is only in the capacity of harbours and channels and the means of supplying and trans-shipping cargo.* The limits to the size of a dredge are only in the magnitude of the work it may have to do to insure that it shall be profitably employed for a sufficient length of time, and also in the facilities for disposing conveniently of the material dredged. The limit to the size of a railway excavator or steam shovel is only that of gauge of track and clearance limits and the capacity of cars to receive and haul away the material. It will be seen that within these limits great possibilities exist, and also that the development of the modern high-powered dredging machine will render possible great works hitherto unthought of, and by deepening channels and harbours will remove the most serious limitation to the growth of the steamship and consequently to the economy of sea transportation.

There is also the mechanical limitation. That mechanical science will be equal to all demands upon it cannot be doubted. Experience proves that whatever is feasible or desirable from a commercial or economic standpoint, can be successfully built from a mechanical standpoint. The growth must be gradual, even if rapid, and built upon the lessons of previous practice. Also experience proves that the highest engineering skill is needed if costly mistakes are to be avoided.

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* The importance of this will be realised when the comparative economy of small and large steamships is considered. Thus the cargo steamer of ten years ago carried 5,000 tons of paying cargo at 10 knots on 8 pounds of coal per ton per 100 miles. The Celtic can carry 20,000 tons of cargo at 17 knots on 4 pounds coal per ton per 100 miles. (See "Economy of Large Ships," *Trans. Can. Soc. C. E.*, Nov., 1902.)

Turning first to the question of land transportation, the machine that has performed the most useful work in preparing the pathway for the railway is the steam shovel, or as it is called in Britain, the steam navvy. The necessary cuts and fills of a railway line are made very cheaply by these most useful machines. It is natural that the steam shovel should find its largest development in America, where railways have to be built cheaply over long stretches of country and where the cost of manual labour is high. A modern shovel for railway purposes is illustrated in Figure 1. This shovel was designed by the writer and built by the Bucyrus Company, of Milwaukee, Wis. It has a steel frame throughout and the car body is 10 feet wide by 40 feet long. It handles a dipper of 3½ cubic yards capacity four times a minute, so that in a good bank when it can fill its dipper the rate of work is 14 cubic yards per minute. It can make a cut 55 feet wide and dump its load 16 feet above the rail. It is worked by a crew of three men on the machine and two to five labourers in the pit, and the coal consumption is

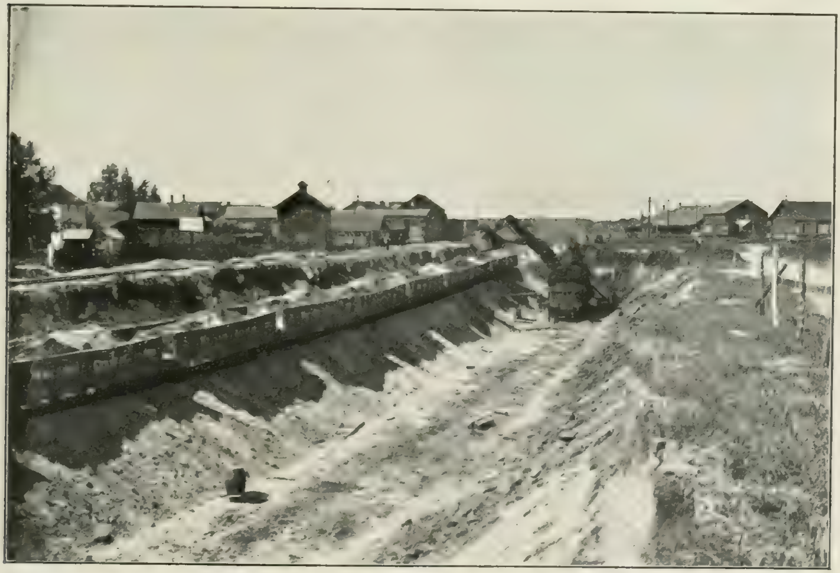


FIG. 2. RAILWAY GRADE REDUCTION BY STEAM SHOVEL. MARION "MODEL 98."

about 1½ tons for 10 hours. The shovel illustrated has a record of 5,880 cubic yards of gravel loaded on cars in 12 hours, and 45,000 cubic yards in 9 days.

To make the great capacity of this shovel available it is necessary to provide car service of large capacity and as nearly continuous as possible. Trains of 25 cars, each holding 20 or more cubic yards and hauled by powerful locomotives, are now used and served past the shovel on a through track, and as soon as one is loaded its place is taken by a second train. The cars are either of the dumping pattern or are unloaded by a "plough" convering the width of the car and hauled over the entire length of the train by a wire rope, this being an operation of a few minutes. In this way the material of a "cut" is transferred to a "fill" at the rate of 3,000 or 4,000 cubic yards per day and at a cost of 4 to 8 cents per cubic yard, including haulage for a short distance.

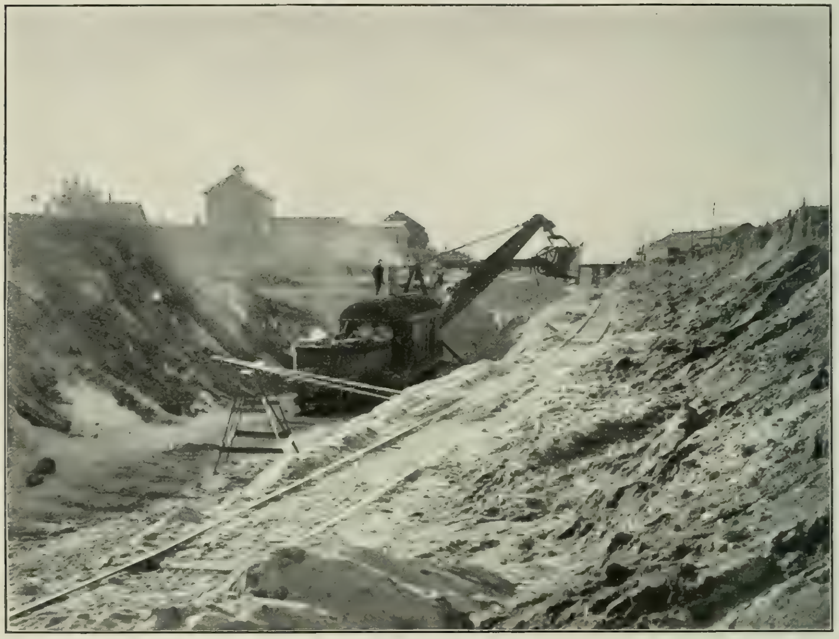


FIG. 3. STEAM SHOVEL AT WORK AT GRADE REDUCTION, WISCONSIN CENTRAL RAILWAY.

In Figures 2, 3, and 4, are shown several views of grade-reduction work by steam shovel. The size of the cut made and the manner of working the trains of cars are clearly indicated. So important a bearing has a straight and level road bed upon the economy with which loads can be hauled, that the older railways are expending vast sums of money upon reduction of grades and straightening of curves. Thus not only in the building of new roads but in the improvement of old ones, the steam shovel finds an ever-growing field of usefulness. In the great iron-ore ranges also the modern method of mining by the steam shovel has been a most important factor in the economy with which American steel is produced.

The American type of shovel differs from the British navvy, in that it is part of the standard rolling stock and can be coupled in a train for transportation, whereas the British machine is usually mounted on four rigid wheels. In addition to convenience for transportation the double trucks of the American machine have the advantage of greater flexibility and distribution of load on soft or uneven ground, and allow it to work more readily on curves. The American shovel has powerful independent engines for swinging the boom and feeding the dipper, and its movements are very fast.

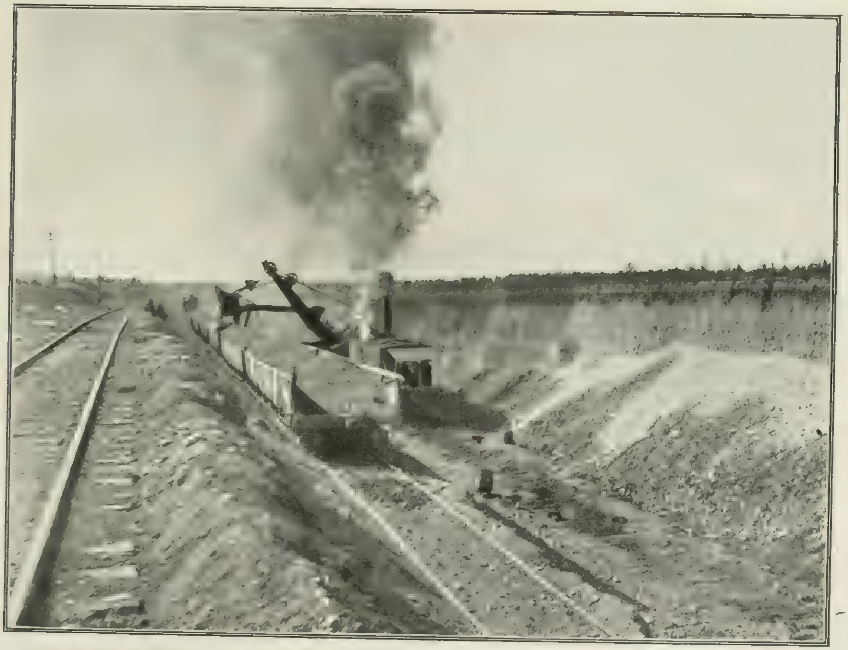
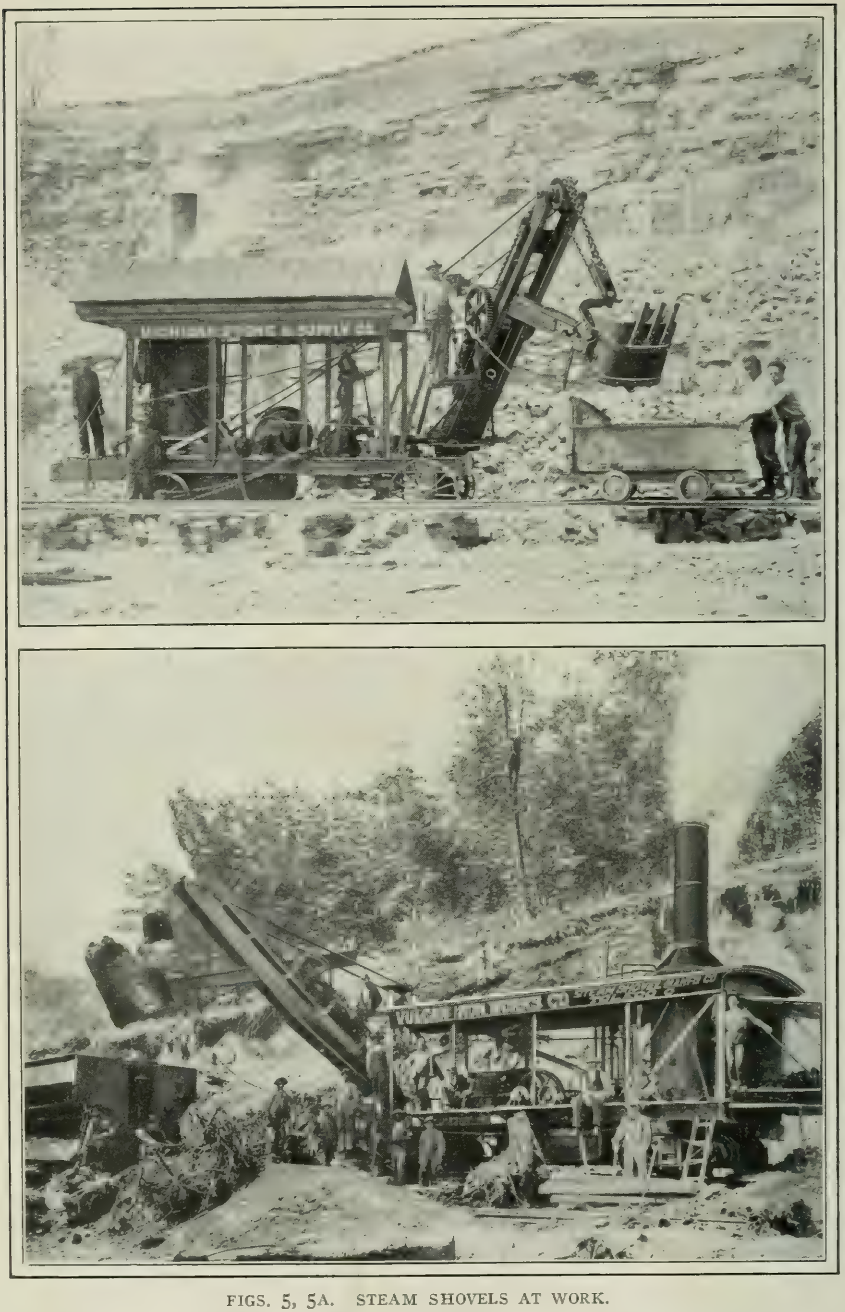


FIG. 4. RAILWAY GRADE REDUCTION BY STEAM SHOVEL, WISCONSIN CENTRAL RAILWAY.

In America there is very little variety in the general type of shovel used. The French and German types of endless-chain machines find no favour. They are considered to be heavier and more cumbersome; they cannot adapt themselves to a wide range of conditions; they re-



FIGS. 5, 5A. STEAM SHOVELS AT WORK.

The upper figure represents a ¾-yard dipper handling broken rock. The lower one shows a 1½-yard dipper on railway work, loading into Goodwin cars. This shovel will dump 13 feet from the track. Capacity 1,500 cubic yards a day.

Vulcan Iron Works Co., Toledo, O.

quire a well laid straight level track of five rails to work on, and they are adapted to load only small cars that will go through the tunnel of the machine. They are inferior to the American type in point of ability to deal with obstructions such as boulders and stumps and to work in rough and irregular ground, and the wear and tear of a chain of buckets and links is very great. On the other hand, it is claimed that as they stand on top of the bank instead of in the bottom of the pit, they have the double advantage of being independent of seepage water, and of requiring less locomotive power to haul away the loaded trains.

One of these machines is shown in Figure 6a (next page) as built by the Lübecker Machinenbau Gesellschaft, of Lübeck, Germany.

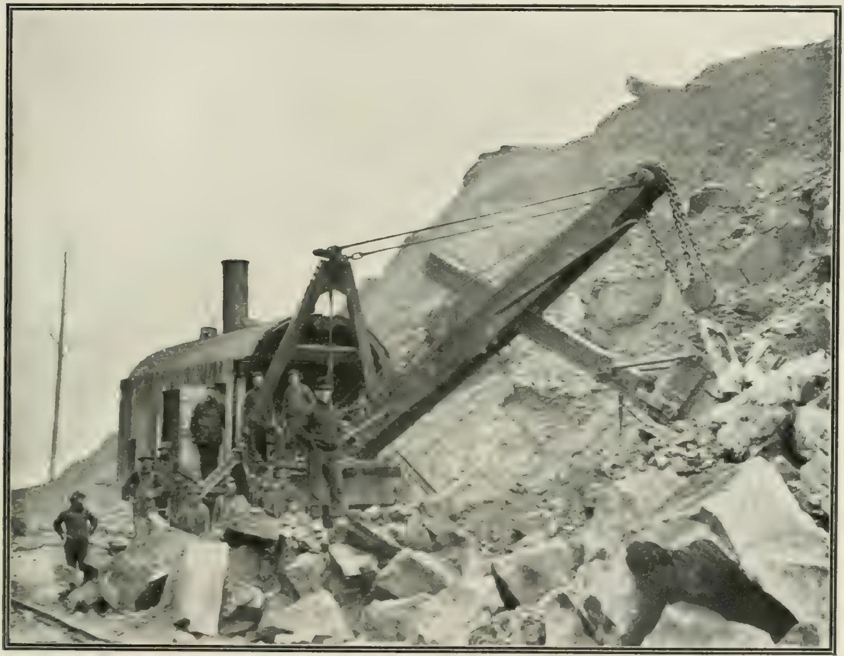


FIG. 6. STEAM SHOVEL LOADING BLASTED ROCK, PENNSYLVANIA RAILROAD.
Marion Steam Shovel Company.

Some shovel builders have endeavoured to improve the strength and capacity by great weight and have brought out machines weighing 90 to 100 tons. This is a mistake. In a locomotive great weight is necessary for adhesion, but in a shovel strength combined with lightness should be the aim, and lightness also contributes to speed.

At the present stage of development the representative American steam shovel for railway use carries a dipper of 3½ to 4 cubic yards capacity and weighs about 75 tons (150,000 pounds). Shovels of 5 cubic yards capacity have been built. Ten or twelve years ago the standard railway shovel had a dipper of 1½ cubic yards and the weight was 35 tons. Improved designs and the use of steel instead of cast iron have done much to increase efficiency, but much improvement still remains before the steam shovel is lifted to the plane of the locomotive in point of careful and scientific design, perfection of detail, and reliability in service. The indications are that for shovel work, chain will be superseded by wire rope and greater speed and power obtained, and also greater reach and lift; but that the size of dipper will not be further increased—at least for railway work. Also steam-pressure will be increased and the shovel generally built on locomotive lines as to design and quality of workmanship.

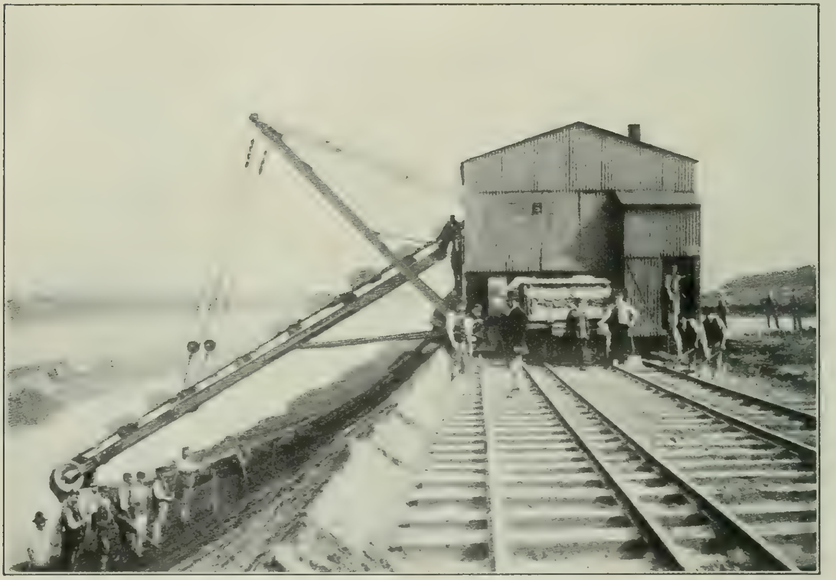


FIG. 6A. ENDLESS-CHAIN ELEVATOR AT WORK ON MANCHESTER SHIP CANAL.
Lübecker Maschinenbau Gesellschaft.

Coming now to water transportation, we find a wider field and a great variety of machines for dredging and disposing of material. Within the limits of this article it will not be possible to do more than touch upon the leading types from the American point of view, with some examples of each, and give some notes on the causes and conditions which have led up to the present state of the art.*

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* In this article the term "American" is used to mean the North American Continent, and not only the United States, and "European" is held to include Britain.

The four established types of dredges are:

1.—The ladder dredge, with chain of buckets.
2.—The dipper dredge, with single dipper mounted on a handle.
3.—The hydraulic or suction.
4.—The clamshell or grapple.

The first type or ladder dredge is most widely used in Europe and from thence sent abroad, but finds little favour in America. In Mr. Corthell's article on European sea-going dredges published in this Magazine, in April and May, 1898, several machines of this type were illustrated and therefore they are not fully gone into here. In that article the lack of such machines in America was taken to indicate a general backwardness in the art. I do not think this altogether a fair conclusion. It is quite true that in large sea-going dredges America has been and is still behind Europe, both in point of numbers and general excellence of design and completeness of equipment.*

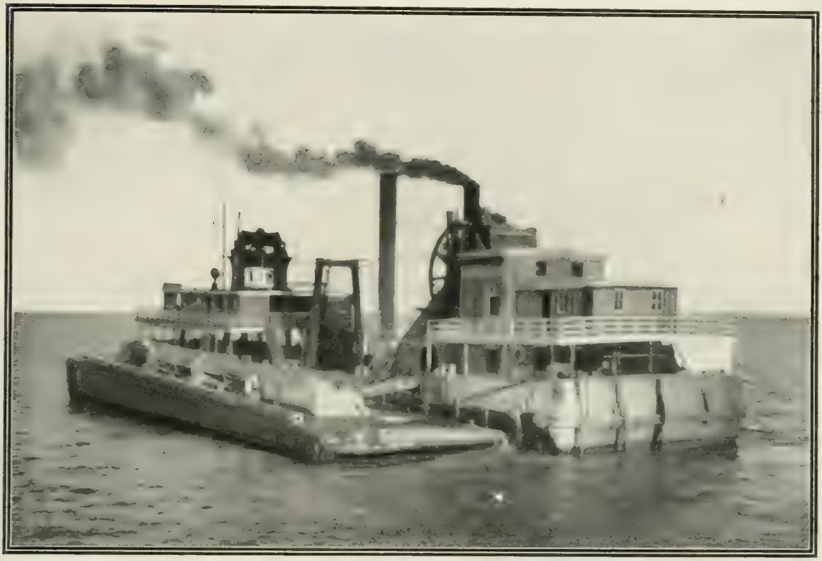

FIG. 7. ELEVATOR DREDGE ABERDEEN, ST. LAWRENCE RIVER.

The reasons for this are twofold:—first, European seaports had a long start of American, and their commerce with the rest of the world was for many years more important and had an earlier development; and second, the methods of administration followed in Europe favoured the creation of permanent plants to execute works gradually carried out on a comprehensive plan at large cost. In America works of this class are under the control of the Federal Government, and are for the most part executed under the small-contract system, according to appropriations voted by Congress; and the main work has been, up to the present, the development of a vast interior country, the seaports receiving comparatively little attention. America is now turning greater attention to seaport improvements, and the development of modern dredges of high power and efficiency may be said to be in its transition stage. While some large and modern dredges are now to be found, most of them are still of small size and of cheap and temporary construction and show no regular system in their design This is due in part to the small-contract system already referred to, under which the contractors of different localities have developed machinery and plant of their own suited to their needs and resources, and in which low first cost and the successful completion of their contract were the main considerations. Older contractors, with more money and experience, developed better tools along the same lines, but there is always the chance of a novice coming along, taking a contract, and building cheaper and more experimental plant to do it with.

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* Although in other ways America excels, as will presently be shown. In the four years since 1898 dredges have been built in the United States and Canada which hold the world's record for size and performance, data of which will be given in the second article.

This system was probably the best for early American conditions. It would be impossible to develop a vast interior country like that of America without carrying on a great number of small and widely separated works under the contract system. Under this system the Government gets the advantage of competition, and usually gets the work done for less than it could by building and maintaining a plant. The contractor builds cheap tools which he can readily take from place to place. These are sometimes special and thrown away at the end of the job, and if more permanently built must be of a design adapted to all kinds of work. He has to pay high wages—about double those for similar work in Europe—and he contrives to accomplish results with his apparently rude and ill-kept plant which would astonish some of the large corporations with their costly and elaborate outfits.

On the other hand, it must be said that the small-contract system has worked disadvantageously for the development of dredging machinery in America, from an engineering point of view. The small contractor gets up his own plant largely by rule of thumb, and is rarely an engineer, and his designs are arrived at by a process of elimination of weak points, and patching up a machine which was crude and ill-designed in the first place. He is limited by questions of first cost and the uncertainty of future contracts. His experience is limited to his own work, and his knowledge is acquired by hard knocks and costly mistakes, which he tries not to repeat, by making the part that broke stronger than it was before, instead of adopting a better design.

In the United States a change has taken place which is having an important effect in producing larger and more efficient plant. The expansion of commerce has made necessary works of greater magnitude, and the Government has adopted the policy of letting larger contracts, sufficient to justify a contractor in building a plant and to allow him time to do it.

Why do we find European dredges principally of the ladder type and of large and complete construction, with steel hulls, while in America we see none of them, but in their stead we find cheap wooden dredges of other types which apparently suffer by comparison? The answer to this question is found in the later development of American seaports, and in the small-contract system as already pointed out.

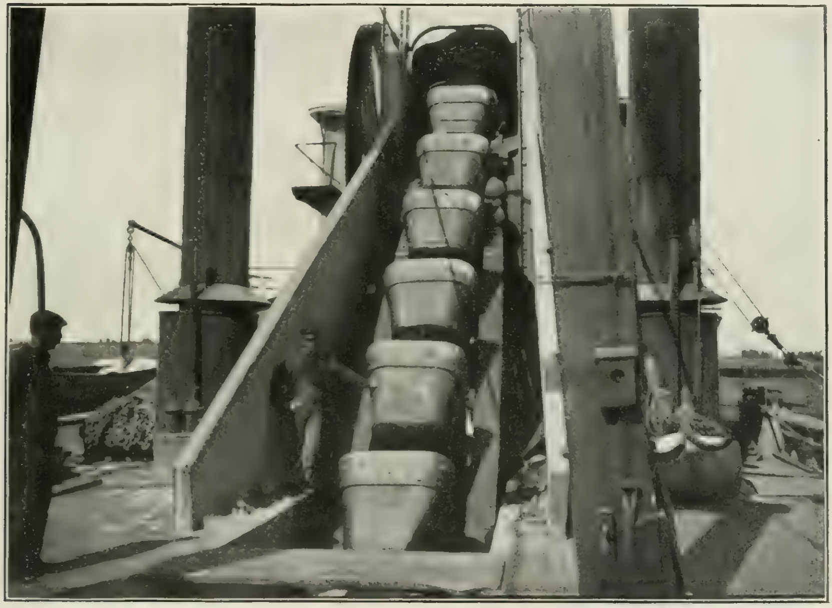


FIG. 8. ELEVATOR DREDGE WITH LARGE BUCKETS FOR SOFT MATERIALS, ST. LAWRENCE RIVER.

The development of the country by small and widely scattered works necessitated small and cheap machines, and thus developed the dipper and clamshell type which suited the conditions better. The American contractor was not going to purchase a steel ladder dredge, costing say $100,000, which would do 3,000 cubic yards a day with a crew of fifteen men, and which required a repair shop to keep it going,

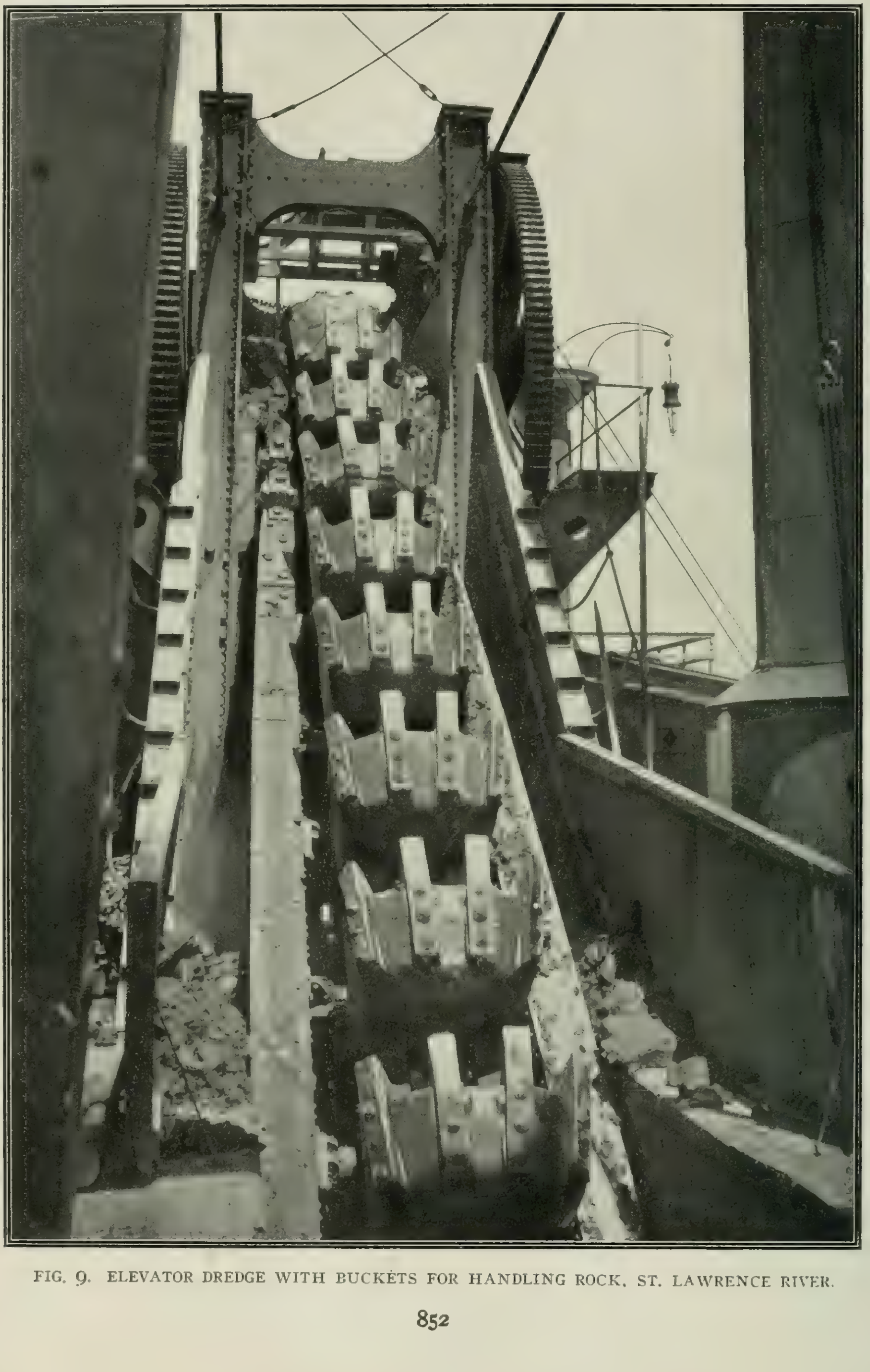


FIG. 9. ELEVATOR DREDGE WITH BUCKETS FOR HANDLING ROCK, ST. LAWRENCE RIVER.

when he could build a wooden clamshell or dipper dredge for $50,000 that would do about as much work under his conditions with a crew of ten men and half the repairs. Permanence was with him no object; he must make money now. In a year or two his dredge would be either worn out, obsolete, or both; he might have a different contract, and would let the future take care of itself.

This is not far from the truth even now, although conditions are rapidly changing. The older and more wealthy contractors are building larger, more permanent, and more efficient plant. The Governments are building larger and more costly dredges. Works are on a greater scale, and we may expect to see a very much better class of plant.

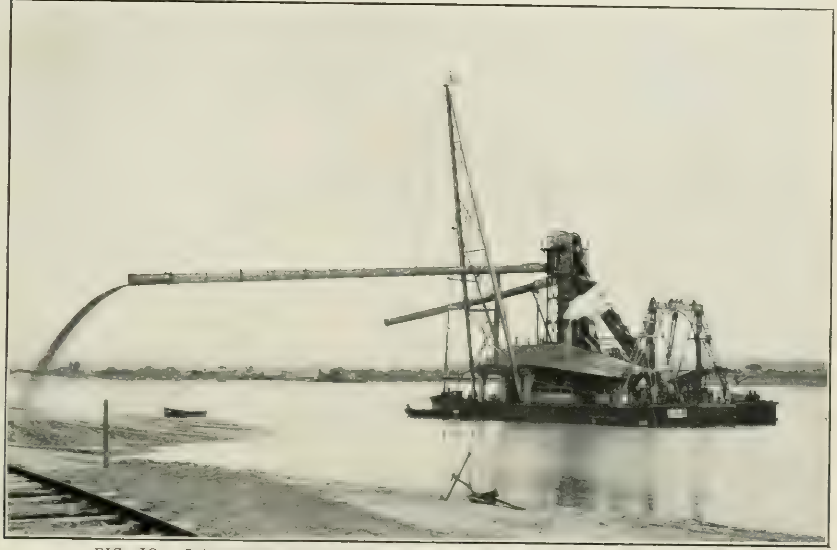
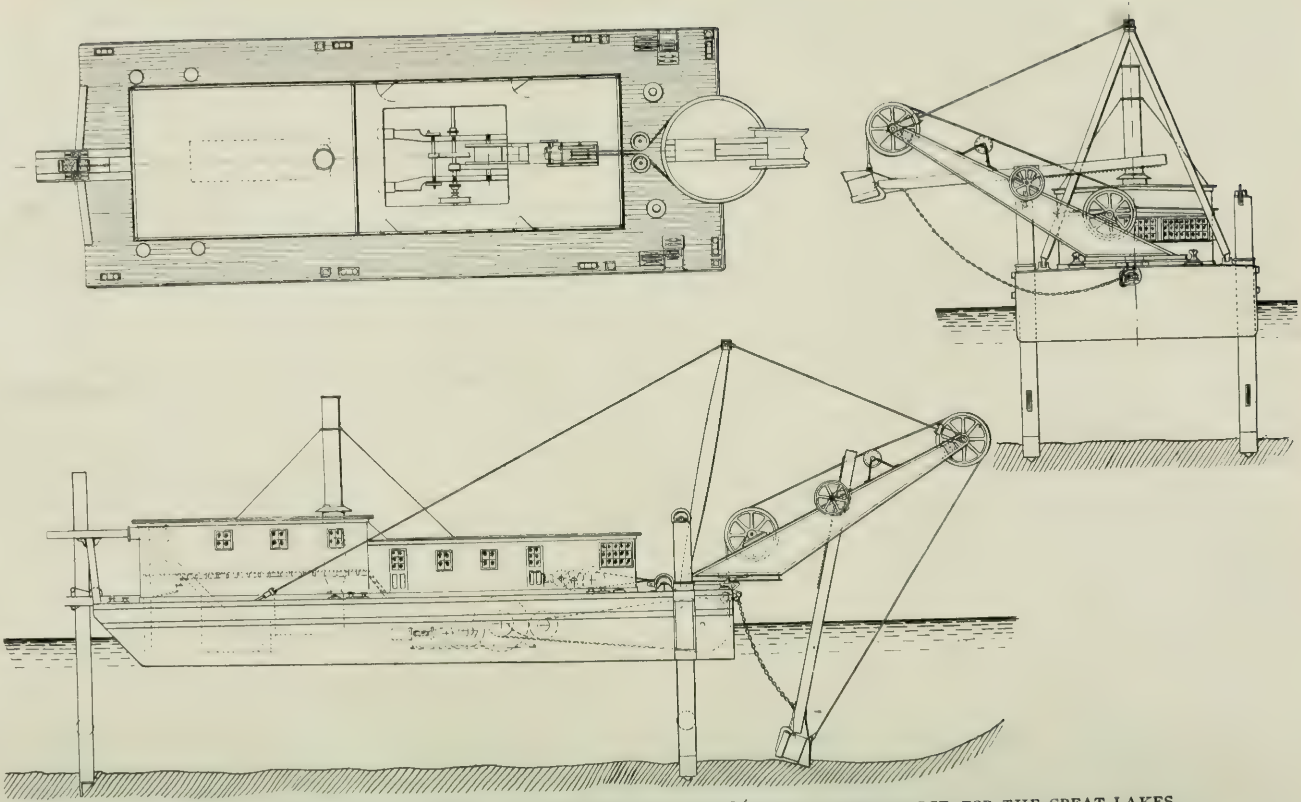


FIG. 10. HIGH-TOWER ELEVATOR DREDGE WITH GRAVITY DISCHARGE.

In Canada, the Federal Government carries on its river and harbour improvements directly through the Department of Public Works, owning and operating its plant and doing but little work by contract. Dipper dredges are mainly used on the lakes and interior, but we find a number of very efficient ladder dredges on the River St. Lawrence ship channel which are the lineal descendants of early dredges of this type imported from the Clyde as far back as 1832. One of these dredges is illustrated in Figure 7. Some of them have large buckets for soft materials, as in Figure 8, and some are fitted with powerful rock-cutting buckets, as in Figure 9.

Vessels drawing 28 feet now come to Montreal, though the original depth was only 10 feet. This is accomplished by 55 miles of



FIGS. 11, 12, 13. SIDE ELEVATION, PLAN, AND END VIEW OF 4½-YARD DIPPER DREDGE FOR THE GREAT LAKES. Scale about 1/24 inch = 1 foot. A. W. Robinson, Mechanical Engineer. See page 860.

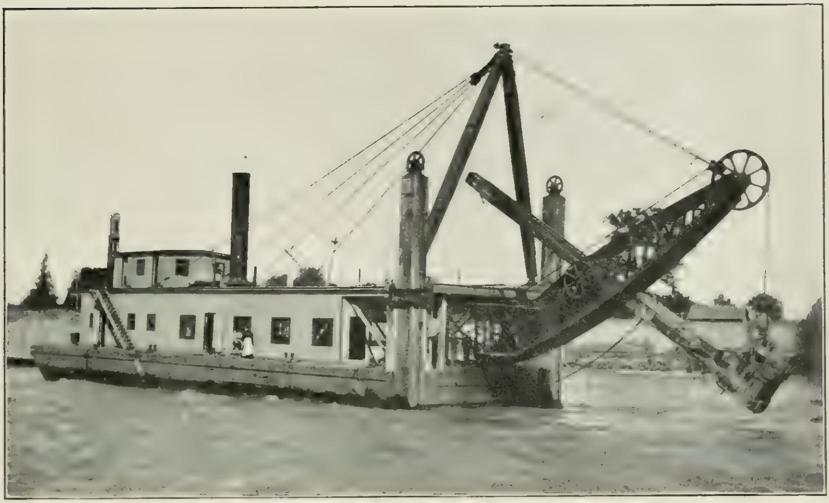


FIG. 14. 6-YARD DIPPER DREDGE ON THE GREAT LAKES.
Hull 120 by 42 by 12 feet. Built by the Bucyrus Company.

dredged channel and the removal of 40,000,000 cubic yards of material. One of these dredges as far back as 1886 made a record for economy which has since been rarely equalled. This was the dredging and depositing of 886,710 cubic yards of blue clay at a total cost of $25,723, or 2 9/10 cents per cubic yard.*

In Figure 10 is illustrated a high-tower elevator dredge, with gravity shore discharge. This illustration is given to show a type of dredge that is practically obsolete. There is hardly any condition in which it could be used that the work could not be better done by a hydraulic dredge, whether for original dredging or for re-handling. The dredge in the illustration elevates the material to a useless height and deposits it so near the edge of the water that much of it runs back again. If it could deposit it dry, it might stand up in a bank; but water must be used to flush the inclined chute. Nevertheless this type of dredge was largely employed on the Suez Canal, and is still used there for maintenance work. The large dredges used on the early Panama Canal by an American contracting company were also of this type and were illustrated in the journals of the day. They had steel towers 50 feet high and a chain of buckets of one cubic metre capacity each, and certainly did effective work for that period. The same difficulty was present—that of depositing the material on the bank in such a way that a large portion of it ran back again into the cut. It is notorious that these machines dredged the same material over a number of times and got paid for it each time.

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* See Reports Harbour Commissioners of Montreal, 1886, p. 80.

I have used the ladder type of dredge extensively in my own practice when conditions warranted it, but as a type it is not adapted to general service conditions in America under the contract system, although it could be used to good advantage on seaport or ship-channel work where the material is other than sand or soft mud and where it could be guaranteed suitable work for a series of years. In sand the centrifugal pump is found to be the best type for economical work, and in mud or silt which is soft and easy to dredge the clamshell or grab of large capacity is a simple and cheap machine giving good results.

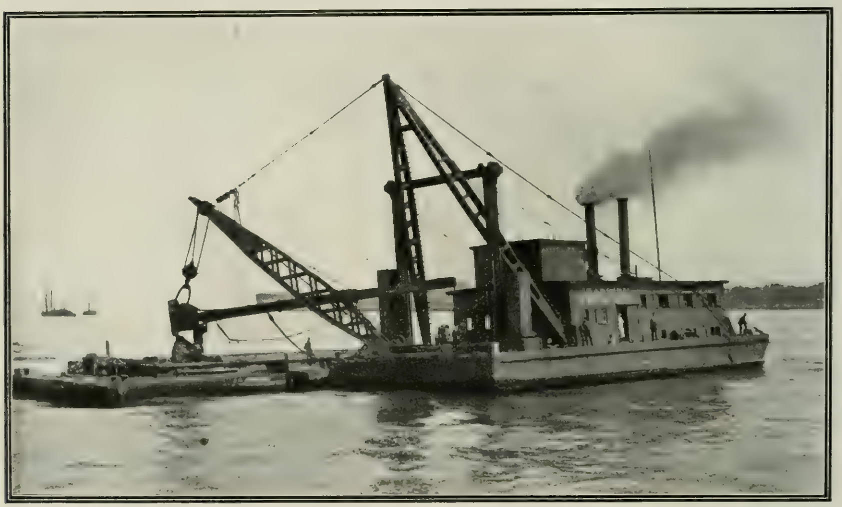


FIG. 15. 6-YARD DIPPER DREDGE AT WORK IN NEW YORK HARBOUR.
Built by Osgood Dredge Co., Albany, N. Y.

America is now passing out of the wooden stage into the steel stage. Good timber is increasingly more difficult to get, while steel is relatively cheapening. Many old dredgemen still regard steel with suspicious eye and wonder whether a steel scow or steel dredge will work as well as wood, and how they will be able to repair it. In the dipper type of dredge the spuds and dipper handles are still made of wood, and defy the steel ones, which lack the springiness and cannot keep their rivets tight. The home of the dipper dredge is on the Great Lakes. There it flourished and in the smaller sizes and in non-tidal fresh water at 20 feet depth was marvellously efficient. A good wooden dredge of ten years ago which cost say $30,000, would do 1,500 or 2,000 cubic yards per 10 hours with a crew of six men on 3 tons of coal.

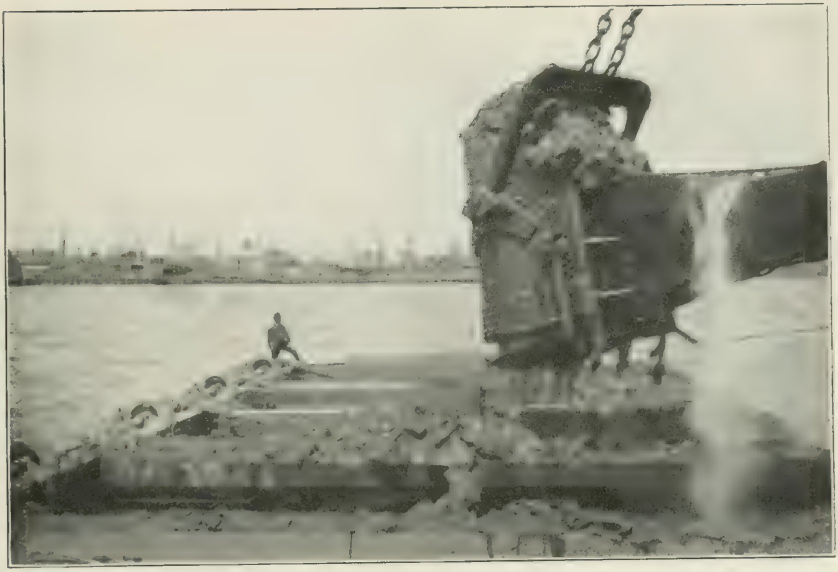


FIG. 16. 12-YARD DIPPER DREDGE EMPTYING INTO 1500-YARD SCOW, HUGHES BROS. & BANGS, NEW YORK HARBOUR.

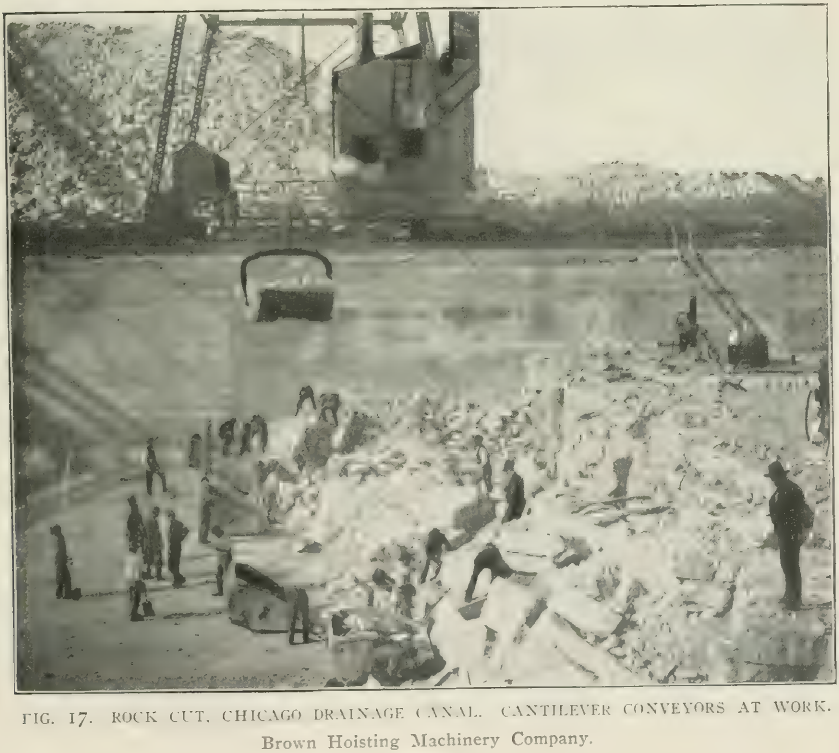


FIG. 17. ROCK CUT, CHICAGO DRAINAGE CANAL. CANTILEVER CONVEYORS AT WORK. Brown Hoisting Machinery Company.

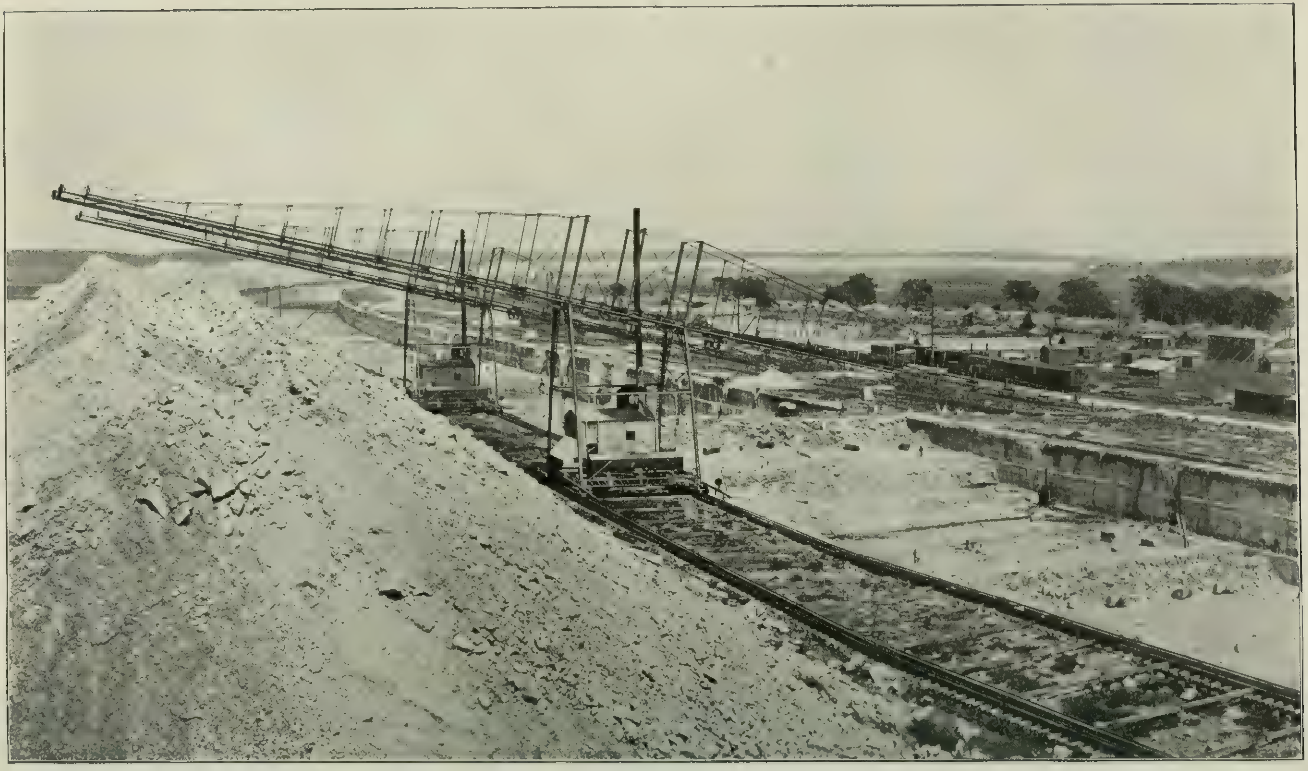


FIG. 18. CANTILEVER CONVEYORS BUILT BY BROWN HOISTING MACHINERY COMPANY AT WORK ON CHICAGO DRAINAGE CANAL.

It could lift its spuds, move up, and reset again in 90 seconds. It stands alone like a table on its legs, with no moorings to obstruct navigation. By means of its dipper on the bottom it can move itself about crab-fashion in any direction, and by the same means can push the barges about which it is loading. It can manœuvre itself in any direction, load scows, dig foundations, pull piles, lay concrete blocks, deposit back-filling, lift boulders, raise wrecks, dredge hard or soft material, and do nearly everything but vote. Its great simplicity made it light in repairs. With tools like these, and suitable for their work, the marvel is not that American contractors do not use the big and costly European ladder dredges, but that these useful American tools do not find a wider recognition in Europe and abroad.

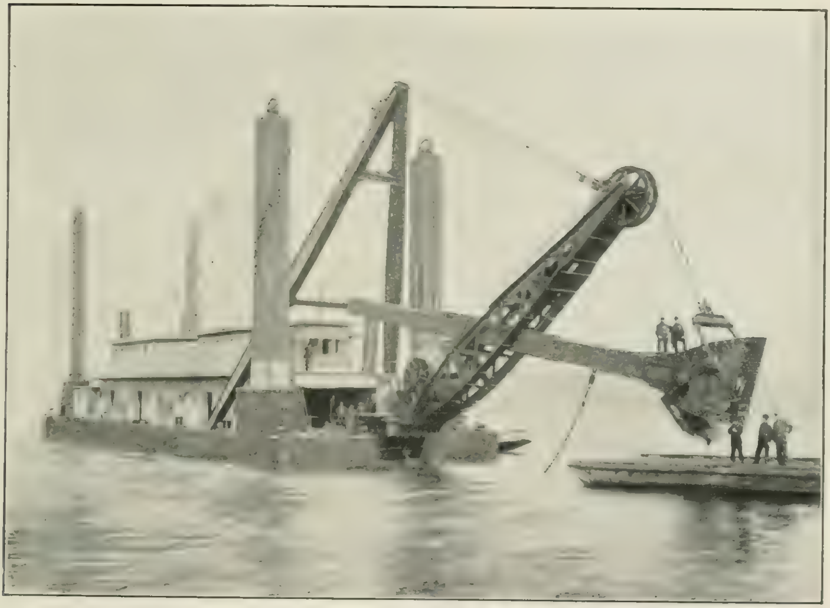


FIG. 19. THE 12-YARD DIPPER DREDGE ONONDAGA.
Hughes Bros. & Bangs.

It must be said that American practice in dipper dredges lacks uniformity and system. An engineer from abroad would find it very difficult to gain a fair impression, as no two machines are alike and many of them are very poor. In appearance, likewise, they are very deceptive. Many an ambitious dredge of good appearance, were its true history known, would make a poor showing of results, while on the other hand a clumsy, wooden, mud-bespattered rival in good hands will jog along steadily and make money for its owners.

On the seacoast conditions are different from the Great Lakes mainly because sea water at 40 feet depth is different from fresh water at 20 feet. The clamshell type prevails, mainly because more of the material is soft, and because this type, straining its spuds less, is better adapted for the deep tidal work, as compared with the work on the Great Lakes. The present standard depth for channels and harbours on the Great Lakes is 21 feet, except Lake Ontario, where it is 14 feet. No immediate increase of this standard is contemplated, as any increase to be effective must embrace the whole chain of lakes. A class of vessel has developed to suit the navigation conditions on the lakes which has grown to enormous proportions in numbers and value. The dipper type, however, is used also on the coast to some extent, as it can dredge harder materials; but the great depth now required for seaports is an increasing tax upon the strength of spuds and dipper handles of this type, as also upon a ladder and chain of buckets.

Modern tidal dredges must now work to 45 feet and the writer has designed one which is intended for hard material in 60 feet of water. This is made necessary by a tidal range of 25 to 30 feet. For great depths the clamshell and suction type have the advantage over the other two types, provided the material is suitable.

The modern type of dipper dredge of the Great Lakes is illustrated by two examples from the writer's designs, a 4½-yard dredge and a 6-yard dredge. The first named is illustrated in outline in Figures 11, 12, and 13, and was built in 1902; the second, Figure 14, was built in 1899. The dredge, Figure 14, was built for M. Sullivan of Detroit, Mich., by the Bucyrus Co., of South Milwaukee, Wis. A duplicate of it was built in 1900 for Daly & Hannan of Ogdensburg, N. Y. As an example of the value of simplicity of type and good detail, the total delays of this dredge during the season of 1901 on account of repairs were only 2 per cent. of the total working time. It has a wooden hull 38 feet by 110 feet by 12 feet. The hull is stiffened by a steel truss. The main hoisting engines exert a direct pull of 120,000 pounds upon the dipper. The dipper is 6 cubic yards capacity and in ordinary material can be worked at a speed of two dippers per minute in 20 feet of water. This speed is rendered possible by the great power and speed of the hoisting engines, and by the adoption of a single part of hoisting rope, which permits the dipper to drop at nearly the velocity of a falling body when released. All motions are performed by friction and without manual effort on the part of the operator. The forward spuds are single timbers of Oregon pine 36 inches square, operated by wire rope from the main engines.

# THE MANAGEMENT OF METALLIFEROUS MINES.

*By Albert Williams, Jr.*

In preceding articles (THE ENGINEERING MAGAZINE for January and February) Mr. Williams discussed the management of metal mines from the viewpoint of the superintendent. The present paper deals in some detail with the relations, duties, and qualifications of the expert force through whom the manager directs and controls the whole working. Suggestions are offered for efficient division of work and responsibility and for economies by combinations and reductions in the staff personnel.—THE EDITORS.

TO a certain extent what is here said applies to colliery organization also. There are obvious differences in requirements between the two classes of mines, but the general idea is the same throughout.

Of course the presence of a staff implies the existence of a mine of some importance to warrant it. For convenience it is assumed that the mine is a large one, productive, and with a large force. From the extent of individualized functions here noted a somewhat alarming impression might perhaps be drawn as to the number (and pay) of assistants to the superintendent, but the due combinations and eliminations can readily be applied to meet any particular case.

Proportioning the staff (with its salaries and complex relations kept in mind) is a matter of nice judgment—often hinging upon financial possibilities rather than purely technical advantages. Its number, expense, and character depend not only on the extent of workings, labor employed, and prosperity, but also on whether the kind of ore handled calls for great or small or varied technical attainments. A big precious-metal mine (gold, silver, or both) with some sort of metallurgical plant attached, exemplifies the most involved organization; but the great copper and iron-ore mines also are intricate affairs. As a general and safe rule the staff should of course be limited in number to what is strictly necessary to smooth running without penny-wise skimping. It should at any rate not be top-heavy, which is quite as bad as being short-handed. There are several ways of economizing, without lessening the total efficiency, which will be considered later.

The staff at the mine gradually shades off into what might be called the petty-officer rank, and it is almost as hard to define just where to draw the fine line between "expert" and "skilled" in the office and outside force as it is between the skilled and ordinary labor—for all real miners need skill in varying degree. Perhaps the best division is on the score of authority. Then besides the regularly employed local staff there may be temporary expert help, and under some conditions an arrangement for joint employment and pay of certain men by companies operating neighboring mines.

Of the regular staff, first comes the assistant superintendent. His duty is to act as executive officer and represent the superintendent or manager in authority, on occasion, while always relieving the latter of all details possible. What is here wanted is fair all-round technical ability rather than much experience, being under the guidance of an older mining man; and the suggestion at once arises that a young and ambitious graduate from a mining school, willing to serve on a moderate salary in view of the opportunity for observation, practice, and future promotion, would about fill the bill. In case the appointing power has no special person in mind, it would be well to consult the head of one of the leading technical schools, asking him to recommend a suitable man, on the strength of his school record and other qualifications. This the school people are always glad to do, and with discretion, for the sake of the reputation of their institutions.

In earlier times the mine foreman filled this berth, and does so yet in many instances; but the other plan is more satisfactory, and the foreman can find plenty of occupation as it is. There is this disadvantage, that the older and more experienced men do not always like to take orders from a younger person with less "practical" knowledge; so that the "kid" (as he is likely to be named) will need all the tact and reserve he has, and should be chary of meddling with details that the other subordinates are competent to cope with, and be always ready to learn tricks that the schools cannot be expected to teach.

At this point mention cannot well be omitted of a section of the local office force which does not strictly come under the head of the expert staff but is closely connected with it, to round out the sketch of organization; that is, the clerical equipment. At the smaller mines the superintendent and the assistant superintendent are able to handle a part at least of the work of this department; but with large operations that becomes impracticable. There may then be need at the mine as well as at the home office, of a local business staff, comprising a cashier or pay clerk, accountant, with time keepers and other clerks. Besides the book keeping and handling of money, considerable work is involved in preparing the mine reports and records. The systems of financial reports and book keeping have already been discussed in the article by Mr. Charleton in the issue of this magazine for January, 1901, and also touched upon by the present writer in the January, 1903, number, so that there is nothing further to suggest now.

The surveyor should be not only an adept in accurate underground work but a good topographer and leveler for surface work, such as laying out roads, tramways, aerial ropeways, possibly railway branches, ditches, reservoirs, sites for buildings, and so on. He breaks in some of the hands about the mine as assistants in holding tape, setting plumb lights, targets, etc. With extensive workings it is necessary to keep up promptly with all advancing headings and see to it that the maps are brought up to date at short regular periods. Nothing need be said here as to instruments (which, by the way are steadily improving in portability and other respects) or as to the general system of notes and records, as all this is well understood by every mine surveyor; but it may be suggested that while a survey is being made the surveyor often has an excellent opportunity to observe features of the ground which should not be omitted from his notes and might be valuable guides in developing the mine. This does not demand any profound geological knowledge; common sense and experience go a long way, although a mine surveyor is naturally supposed to know something of field and economic geology.

Considerable trouble may be saved in short-distance work by simple compass-and-tape measurements, checking up from time to time with regular instrumental surveys. It is not indispensable to lug a transit into the mine every day or every week. On the other hand it is better that the surveyor himself should kep track of progress everywhere in the mine, not relying wholly on shift bosses—on contract work, for example—and see that back pegs do not become mysteriously automobile.

Not all surveyors fully appreciate the convenience of the graphic method, worked out on the drawing board with scale drawings and protractor, for laying off short connections, and thus dodging the trigonometry. The tendency, and rightly too, is for a careful surveyor to calculate everything with the closest exactitude after the most painstaking adjustments and checks of survey, and it is rank heresy to suggest anything else. Still—and the hint is thrown out for the benefit of superintendents who employ no regular surveyor—a great deal can be done in the way of short-cut wrinkles. There are occasions where the nicest refinements are essential and unavoidable, as in running long drainage adits, making connection with old workings, or meeting approaching headings, and amazingly close work has been done in this line; but what applies to cases involving the hundreds and thousands of feet does not always hold with the fifties, seeing that a theoretical accuracy down to small fractions of an inch in a connection is wholly obscured by the inevitable roughness of the actual result.

There can hardly be too much detail in the large-scale maps of a big mine, not only for current uses, but to serve as records in case of shutting down, caving, and opening of new workings from which connections are to be run. If there are many surface improvements a cadastral map is needed, besides the plain topographical one. Boundaries and relations of contiguous mines, roads and railways, etc., should be clearly indicated. There should be a general underground plan (say 1 inch = 50 feet or less) showing all the different levels and inclines superposed. The working plan of each level should be on a very large scale, say even up to 1 inch = 10 feet, in separate sheets if necessary. The general longitudinal section along the strike may be either a vertical projection or made in the plane of the dip of the lode, and should show all shafts, inclines, winzes, location of cross cuts and trace of stopes (stoped ground on a flat or low-dip bed may also be shown in horizontal plan). Transverse sections are made along the plane of the principal cross cuts or cross-cut adit, or normal to the strike, and are of the same scale as the general horizontal plan and longitudinal section. Only two scales are needed for the working maps, and each set is correlated throughout as to scale.

All possible information as to important points developed in the workings should be indicated, known limits and courses of ore bodies platted, position of diamond-drill holes recorded, etc. Besides the regular draughtings, for reproduction in annual reports or prospectuses and for the information of the home office, still smaller-scale plans, sections, and maps, giving a general exhibit of the lay of the ground, showing the work done between certain dates, and omitting confusing details, may be found handy and useful.

The original plattings should be on mounted paper, preserved untouched as far as may be, and muslin tracings made from them. The originals have the distinguishing colors; the tracings to be used for making blue prints are of course in black-and-white only. Sets of blue prints are then made, and those sheets much referred to and handled should be backed. It is a convenience to avoid rolling, and cases of drawers should be provided to keep the sheets flat and clean, besides which wall copies may be hung for ready reference.

Arbitrary signs and colors may be used to give much information at a glance and distinguish the workings and also geological formations. For the horizontal plans a color scheme may be adopted to distinguish ten to fifteen levels on one projection, and then repeated, for very deep mines. The colors used to indicate geological features should be plainly contrasting, rather than according to any of the standard color schemes of the books, in which related rocks or formations are represented by tints not sufficiently distinct in each group. Shafts, winzes, and inclines should have dimensions and number of compartments shown, upraises distinguished from sinkings, and surface mouths from blind connections. A complete legend should be added in a corner of each sheet, explaining signs, letters, and colors, perhaps giving other details. Mine surveys and maps are usually "magnetic"; if so, a correction for "true" is added, especially when the workings are expected to be occupied long in the future.

Some mines have enough work to keep a mechanical draughtsman busy, and at establishments having much plant with a machine shop and foundry annexed, a draughtsman who is also something of a designer is a useful man.

The assayer at a mine where there are no reduction works, or only simple plant such as a concentrating mill or a small gold mill, has a comparatively easy job and can arrange his work on a daily routine plan. In a well managed mine all the working faces are carefully sampled at regular intervals if there is any sign of ore, and in some formations not only the evidently very low-grade ore is sampled and assayed, but also the country rock itself, as offering a clue to direct the underground prospecting. This may call for considerable expertness on the part of the assayer in determining minute tenors of metal, involving the use of strictly chemically pure reagents and fluxes which he may find it expedient to prepare for himself, or at least to check with standards and blank assays; and to get weighable buttons or precipitates he may be compelled to combine many assays or rely upon optical measurements by the Plattner scale and microscope with micrometer stage, or similar refined methods.

The samples are variously taken according to approved methods underground, as by upper, middle, and lower cuts across the full width of the heading, or across (and at right angles to) particular seams; and it is usually the practice to have the breaking, mixing, and quartering down done at the assay office. There may also be special samples of specimen ore or of peculiar minerals. The assayer generally receives instructions from the superintendent or underground foreman, when the samples are delivered, as to the precise object in view so that he may govern his procedure accordingly. The small samples after quartering down are best held in 4-pound or 6-pound canvas sample bags (scrupulously freed from former contents) with numbered tags, the numbers corresponding to memoranda as to nature and purpose of sample and exact locality from which derived.

It is expected that the assayer will be able to determine minerals by the eye and ordinary physical and blowpipe tests, and to distinguish the common rocks lithologically.

Besides the samples taken in the mine, run-of-mine samples are taken from ore cars, bins, or dumps, and of each shipment, for which purpose the common shovel method when loading or dumping suffices with most ores of fair uniformity and not too high grade, in which latter case greater care and perhaps running the whole lot through a sampling machine may be necessary. If there is a concentrator at the mine, the crude ore, the product at various stages of concentration, the tailings, and the slimes are, or ought to be, constantly sampled and assayed. Whenever possible and convenient it is best for the assayer to do his own rough sampling, and of course the final samples for assay and for an umpire assayer (in case of shipment and sale of ore) are prepared by him.

The selection of the site of the assay office is of some importance, means of delivering fuel and ore by gravity being worth having. The fittings of the office are suited to the kind of ore the mine produces, and should include a small rock breaker (run by wire-rope power transmission, if available), sampling apparatus capable of working down lots of considerable bulk, with the usual furnaces and apparatus and chemicals for wet analysis and color tests, as the case may require, scales and chemical balances, blowpipe kit, low-power microscope, testing outfit, etc. The assayer will need one or more helpers for firing and chores. If there is an extensive reduction plant operated in connection with the mine the assayer's duties become indefinitely enlarged and he may require a more elaborate equipment and several helpers, besides finding it convenient to locate his office at the metallurgical works.

System is maintained in the assay office by keeping regular records of all samples, tests, results, materials consumed, etc., with daily reports to the manager at stated hours. Blank printed forms and suitably ruled books save time and promote regularity.

So much electrical machinery and apparatus is in use nowadays that an electrician is often regularly employed at a large mine, with perhaps one or more helpers. In isolated localities a man is required who is capable of installing plant, running it, and making repairs, so as to be independent of outside assistance. For a large plant the electrician should be more or less of an hydraulic engineer, steam engineer, and machinist; should understand the measurement of water and water power, the control of water supply, reservoirs, dams, ditches, flumes, pipes, etc.; turbines and impact wheels; steam engines, shafting, gearing, etc.; and all machines to be run by electric power. In his own particular field he has to install, manage, and repair the generators, wiring and supports, transformers, and motors of various kinds, surface and underground hoists, haulage, pumps, compressors, fans, drills, etc. Then if there is an electric-power installation there will be also the lighting to look after. Signalling by electric bells and the telephone or telegraph may also come in.

There is usually one head underground foreman, aided by shift bosses; or there may be a day underground foreman and one for the night. The duties are supervisory in big mines (though he works with his hands in the smaller ones) and bring him into direct contact with all the underground force, for whose efficiency he is responsible. He is preferably a promoted miner of skill—steady, watchful, and reliable, for very much depends on him.

Large mines have also a day and a night surface foreman, who have in charge the general oversight of all surface plant and property and direct the surface labor. Other men of the skilled mechanic class, rather than the staff proper, are the head machinist and foundryman, head blacksmith, head carpenter and timberman, engineman, pumpman, ropeman, and their helpers; while underground are also station tenders, power-drill operators, and runners of various haulage, hoisting, and pumping machinery.

Thus far nothing has been said of that important man, the metallurgist, since his department is usually apart from the mine organization and may be an entirely independent establishment situated at some distance. With reduction works at the mine, the man directly in charge of them reports to the general manager or superintendent, and has his own staff of subordinates who are under his immediate orders. This introduces practically a new organism—an entity in itself, with its own specialists and labor force, too varied and intricate to be even briefly described in this limited space. The chief metallurgist, whether millman or smelter, must be a man of experience and thorough grounding if his field is at all a difficult one; it often happens that the success of the whole enterprise may depend even more upon his ability than upon the running and the productiveness of the mine itself. He is generally a specialist, in the sense that he has given attention mainly or wholly to some one line.

To sum up, there may be at a great or even a fairly moderate sized mine, in addition to the "working force" of miners, carmen, stokers, common laborers, teamsters, etc., the following organization and staff (whether termed expert or not) all more or less indirectly effective in the management and output:—

The manager, agent, or superintendent (either in a single individual or two, with business and technical functions divided).
The assistant superintendent.
The clerical force and time keepers.
The surveyor and draughtsmen.
The assayer and assistants.
The electrician and helpers.
The underground foreman or foremen, with shift bosses, station tenders, timberman, pumpman, operators of underground machinery, blast firers, etc.
The surface foreman or foremen.
The head machinist and foundryman, the enginemen, etc.
The head blacksmith and helpers.
The head carpenter and helpers.
Other skilled mechanics.

And, if there is a reduction plant:—

The chief metallurgist (millman or smelter).
His immediate subordinates (in varying specialties and number, according to the kind of works).

Now all this means a considerable number of men having more or less official footing, none of whom actually produce (directly) a pound of ore or an ounce of metal—in addition to the large number of skilled and unskilled workmen who also are not engaged in the visible mining. How can this staff be simplified and reduced without injuriously affecting the purpose of the enterprise—the production and disposal of ore—so as to fit the managerial and auxiliary personnel to the needs and capacity of the mine? There are several considerations which will at once occur to the reader:

1. Elimination—that is, lopping off all functions which do not bear upon the particular case in point. Obviously, for instance, an hydraulic placer mine does not want an assayer, underground foreman, and most of the skilled mechanics; and after the ditch, flume, pipe, and sluice lines and cuts or tunnels have been laid out, the surveyor is

dispensed with. A large production might be had with a force consisting of a superintendent, one foreman, and a very moderate number of pipemen and laborers. A big stripping iron or manganese mine would want no surveyor after certain measurements had been made and tracks put in, and no assayer, for the samples would be sent elsewhere; so that the superintendent, clerks, foremen, and operators of the excavating and loading machinery would be about all the force except common labor required for a very heavy output. And so on with other classes of mines. The assistant superintendent might become a fifth wheel. In general, the number of foremen and clerks increases with the number of working hands, and the expert staff is cut down in proportion to the simplicity of the operations. If there is no reduction plant, that may eliminate about half the staff; if there is no machinery, then there is no need for an electrician, machinist, enginemen, etc.

2. Combination of functions in a single individual. A previous paper has shown how this is effected in the case of the superintendent. Then he may take charge of the business and clerical work or divide it with the assistant superintendent. The latter may do the surveying and draughting. The millman may be also the assayer—and so on.

3. Joint employment of individual specialists by two mines or a group of mines. This applies to nearly the whole staff, and is a frequent custom. It may reduce the number of berths open to newly graduated technical students and others; on the other hand it creates employment for a small number where otherwise there might be none. One ownership often operates adjoining or neighboring mines, when the plan is naturally resorted to and is carried out as far as warranted by circumstances; but two companies often combine in sinking and operating joint shafts or running joint drainage adits, and likewise have an assay office, mill, etc., in common, so that an arrangement for dividing the salary expense of several mine officers follows.

4. Reliance on outside assistance. In the older and more settled mining districts there are always one or more independent surveyors, usually an assay office, sometimes sampling works and testing laboratories, so that a mine which cannot afford or has not full-time work for expert help has a ready recourse. For special emergencies consulting engineers are called in to advise as to development of ground, selection of machinery, choice of metallurgical process, and difficult or unusual expert jobs. It is the small isolated mine which is at a disadvantage.

# COST-FINDING METHODS FOR MODERATE-SIZED SHOPS.

*By William Magrutor.*

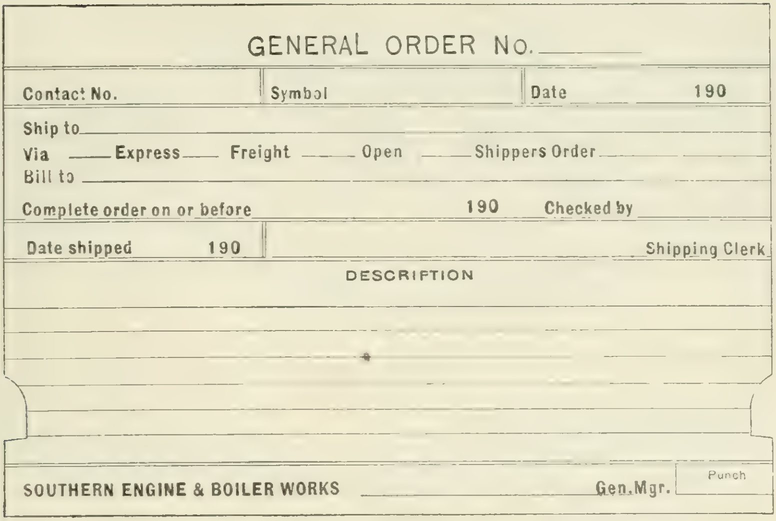
## THE SYSTEM OF THE SOUTHERN ENGINE AND BOILER WORKS.

**The series of articles of which this is the fourth began in December with an account of a system in use in a well-managed boiler shop. In January the example taken was a machine-tool works using the premium plan, and in February, a printing press factory in which stock-tracing was a peculiarly important feature. The purpose of every article is to furnish a working description of a practical system, in actual use in a shop where it has stood the test of time and proved sufficient, and with it to give fac-simile reproductions of all forms and blanks. This makes the papers particularly useful to those concerned with shop accounting.—The Editors.**

THE Southern Engine and Boiler Works, of Jackson, Tenn., manufacture Corliss and slide-valve engines, boilers, and saw-mill machinery, and employ about three hundred men. The business was organized about 1884, and re-organized in 1889. The present general manager, upon taking charge of the office, was quick to perceive the necessity of a system combining thoroughness with simplicity. The following system devised by the mechanical engineer of the company and put into effect by him has proven highly satisfactory, no changes having been made since its installation. In this method all records are kept on cards adapted to index filing, no books being necessary. This method saves labor of transcription; the record is more readily accessible, with vastly less labor and no delays caused by posting, while the similarity of orders makes it extremely simple, and the uniformity of cards, there being but two sizes, has rendered the filing of records both easy and convenient.

The general manager has absolute control, and the factory is divided into two departments—Production Department and Business or Accounting Department; the production department is subdivided as follows: drawing room, pattern shop, foundry, machine shop, blacksmith shop, saw-mill department and boiler shop.

The shop neither builds nor repairs any machinery except by written order from the general manager. In issuing an order for a machine, the general manager fills out two General Order cards No. 1; he retains one at his desk and sends the other to the superintendent, who place it on temporary file, and issues Production Order No. 2, to the different foremen. If, however, the order is for a new machine,



GENERAL ORDER No. ______

Contact No. | Symbol | Date 190

Ship to ______

Via ____ Express ____ Freight ____ Open ____ Shippers Order ______

Bill to ______

Complete order on or before ______ 190 Checked by ______

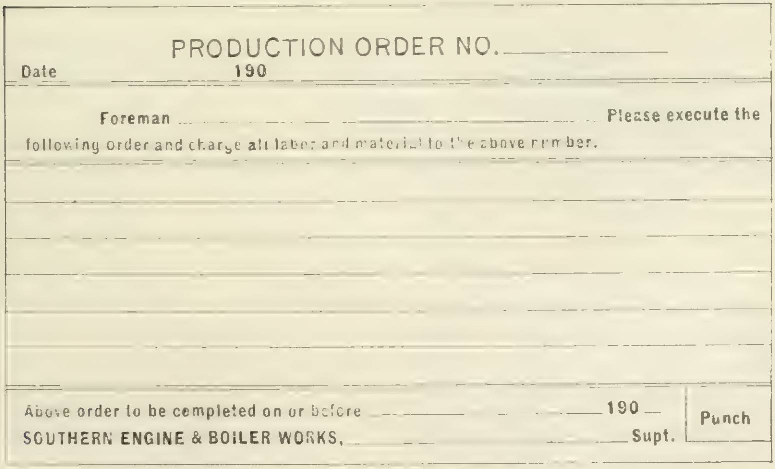
Date shipped ______ 190 | ______ Shipping Clerk

DESCRIPTION

SOUTHERN ENGINE & BOILER WORKS ______ Gen. Mgr. | Punch

FORM 1. GENERAL ORDER. 6 BY 4 INCHES, BLUE CARD.

or embraces any change from the standard, the superintendent sends the general order to the draughting room to have necessary drawings attached and returned to the superintendent, who disposes of them as above stated. The superintendent and foremen through whose hands the different orders pass do not sign their names, but use a conductor's punch, each cutting a different shaped hole in a square on the card indicated for this purpose. This is true of all orders; they are



PRODUCTION ORDER NO. ______

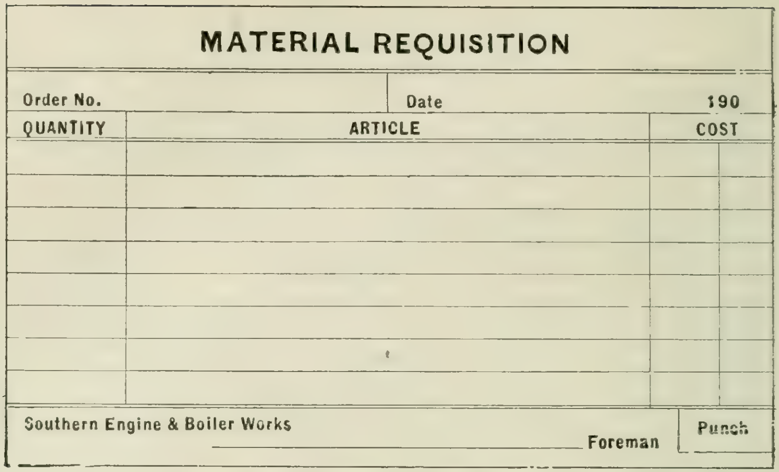
Date ______ 190 ______

Foreman ______ Please execute the following order and charge all labor and material to the above number.

Above order to be completed on or before ______ 190 ___

SOUTHERN ENGINE & BOILER WORKS, ______ Supt. | Punch

FORM 2. PRODUCTION ORDER. 5 BY 3 INCHES, BLUE PAPER.



**MATERIAL REQUISITION**

Order No. Date 190

| QUANTITY | ARTICLE | COST | |
|---|---|---|---|
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| | | | |

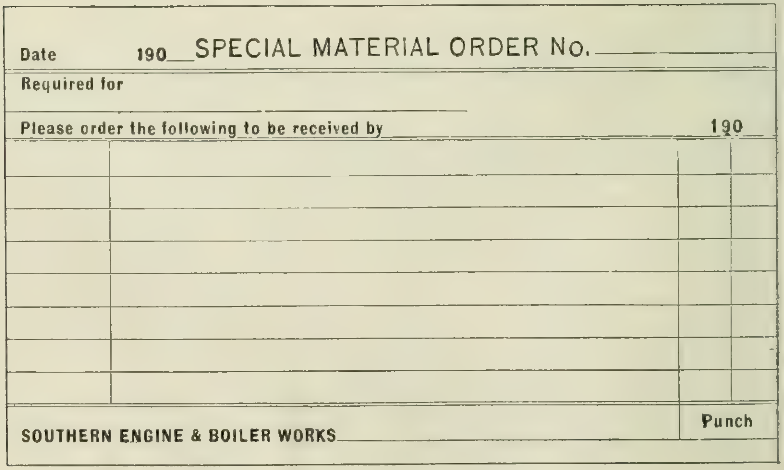
Southern Engine & Boiler Works

Foreman

Punch

FORM 3. MATERIAL REQUISITION. 5 BY 3 INCHES, YELLOW PAPER.

signed by the proper person issuing them, and all others through whose hands they pass use punches. This enables every action which has been taken on an order to be recorded without covering it with notes and signatures. The production cards, issued by the superintendent to each foreman, bear the same number as the general order, and are issued in duplicate. These are in book form, gummed together at the end, so as to be readily detached. One is retained by the superintendent, who places it on temporary file with the general order of the same number. The other copy is sent to the foreman, who makes



Date 190 SPECIAL MATERIAL ORDER No.

Required for

Please order the following to be received by 190

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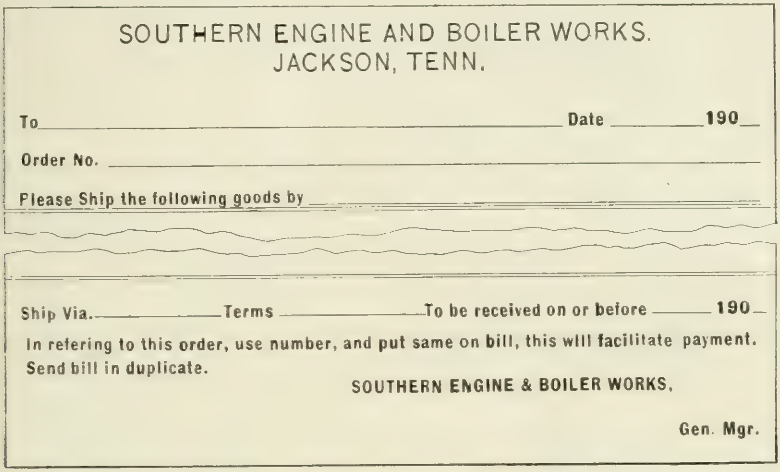
SOUTHERN ENGINE & BOILER WORKS

Punch

FORM 4. SPECIAL MATERIAL ORDER. 5 BY 3 INCHES.

out Material Requisition, No. 3, numbers it the same as the production order, and sends it to the store keeper who fills out an order and returns the original order to the foreman with the material, entering the cost of material, or fittings, in the cost column, using for that purpose a cost mark which is understood by the cost clerk, the superintendent, and himself. The foreman attaches the material requisition to his production order.



SOUTHERN ENGINE AND BOILER WORKS.
JACKSON, TENN.

To____________________ Date ________ 190__

Order No. ____________________

Please Ship the following goods by ________________

Ship Via.__________ Terms __________ To be received on or before ______ 190__

In refering to this order, use number, and put same on bill, this will facilitate payment.
Send bill in duplicate.

SOUTHERN ENGINE & BOILER WORKS,

Gen. Mgr.

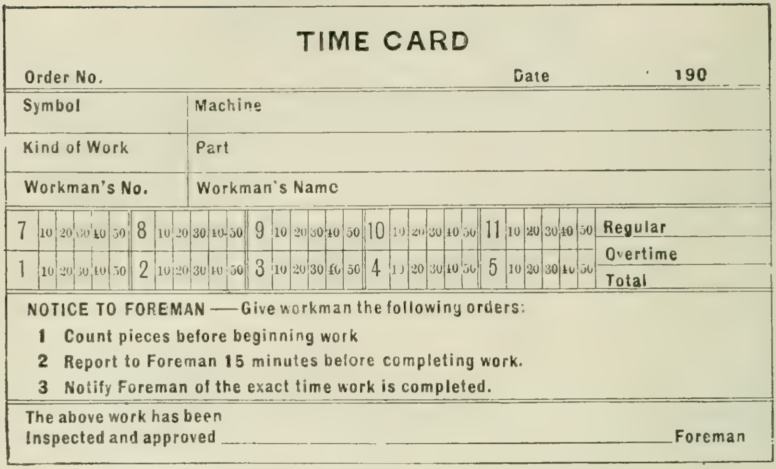
FORM 5. PURCHASING CARD OR SHEET.

Reproduction shows heading and footing only. The original is 6 by 10 inches, white paper.

If special material has to be ordered for the job, the superintendent fills out Special Material Order, No. 4, numbering it the same as the general order, and making stub entry, and sends it to the general manager, who fills out the Purchasing Card, or a sheet, No. 5, making a stub entry or a duplicate. He then returns the special material order, No. 4, to the superintendent, who is thus informed that the material has been ordered, and he will know when it is to be received. The superintendent files his special material order with his general order.

Upon receipt of the bill for special material, which is usually in duplicate, one copy is handed to the superintendent, who files it with the original special material order, No. 4. If, however, the material bills are not issued in duplicate, the manager marks "Return" across the face of the bill, and sends it to the cost clerk, who makes the proper entries on the special material order which the superintendent has on temporary file, and returns the bill to the general manager.

When the foreman receives the necessary material on a production order, No. 2, he assigns the job to one or more of his men, and makes



**TIME CARD**

Order No. Date 190

| | |
|---|---|
| Symbol | Machine |
| Kind of Work | Part |
| Workman's No. | Workman's Name |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 10 | 20 | 30 | 40 | 50 | 8 | 10 | 20 | 30 | 40 | 50 | 9 | 10 | 20 | 30 | 40 | 50 | 10 | 10 | 20 | 30 | 40 | 50 | 11 | 10 | 20 | 30 | 40 | 50 | Regular |
| 1 | 10 | 20 | 30 | 40 | 50 | 2 | 10 | 20 | 30 | 40 | 50 | 3 | 10 | 20 | 30 | 40 | 50 | 4 | 10 | 20 | 30 | 40 | 50 | 5 | 10 | 20 | 30 | 40 | 50 | Overtime<br>Total |

**NOTICE TO FOREMAN**—Give workman the following orders:

1 Count pieces before beginning work
2 Report to Foreman 15 minutes before completing work.
3 Notify Foreman of the exact time work is completed.

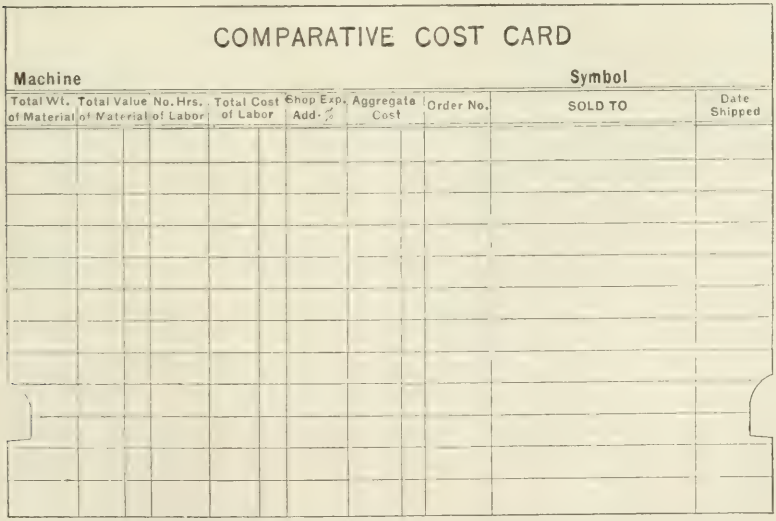
The above work has been
Inspected and approved ______ ______ Foreman

FORM 6. TIME CARD. 5 BY 3 INCHES, PINK CARD.

a cross on Daily Time Card, No. 6, showing the time the workman begins. When the work is completed, he crosses the time of completion; the card is issued at the beginning of each job, or day. The time card bears the same number as the production order. At the completion of the order, he attaches the workman's daily time card and the material requisition, No. 3, to the production order, and returns the cards to the superintendent, who files them with the general order until it is completed—that is to say, until each foreman has completed his part, and made his report as above. This includes testing, painting, and crating. Then the superintendent attaches the production order to the material requisition, and the workmen's daily time cards of the several foremen to his original general order, and hands the whole file to the cost clerk, who makes the proper entry on an Individual Cost Card, and also on the Comparative Cost Card, No. 7. These individual cost cards are filed in numerical order, and show the total cost and the cost of each factor entering into the construction of that machine. comparative cost cards, No. 7, are provided, one for each line of standard machinery—that is, one for each size of machine. These cards show the comparative cost of all these machines, and are in duplicate, one set being in possession of the superintendent, and the other in possession of the general manager. At the completion of each machine the cost clerk makes proper entry on both the superintendent's and manager's cards. This comparative cost card enables the manager to see what each machine has cost, and also to check any irregularity in the production. It also serves the general manager as a stock list, as he can see how many completed machines he has in stock at any time, it being remembered that the cost clerk makes these entries as soon as the machine is completed. This gives the general manager the exact cost of the machine, and informs him that the order is in the hands of the shipping clerk. The manager can see by referring to his general orders, No. 1, on temporary file, the number of machines in stock, the number of machines in course of construction, when they are to be completed, how many of these have been sold, and how many are for stock.

The general order which was received from the superintendent, the cost clerk gives to the shipping clerk—that is, if the machine has been sold; otherwise, the general order is handed direct to the general manager. The shipping clerk after executing his part of the order and making the proper entries, returns the order to the general manager. His entry upon the general order informs the manager of the completion of the order. The manager files the general order returned to him numerically; the one he has on temporary file is filed alphabetically. Thus the two original general orders are filed in such a way that they may be found at once from the number of the order, or the name of the purchaser. It is understood that the machine always bears the same number as the order.

All orders for repair work come from the manager's desk. He fills out Repair Order, No. 8, in duplicate, retains one on temporary



COMPARATIVE COST CARD

Machine Symbol

| Total Wt. of Material | Total Value of Material | No. Hrs. of Labor | Total Cost of Labor | Shop Exp. Add·% | Aggregate Cost | Order No. | SOLD TO | Date Shipped |
|---|---|---|---|---|---|---|---|---|
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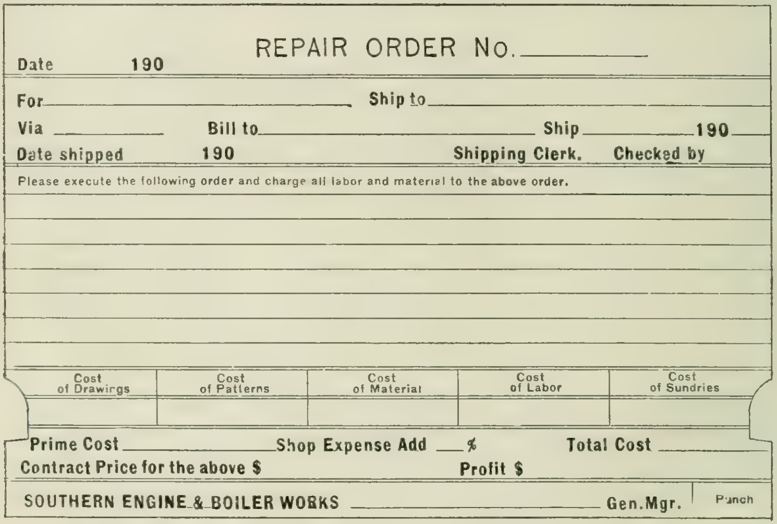
FORM 7. COMPARATIVE COST CARD. 6 BY 4 INCHES, YELLOW CARD.

file, and sends the other to the superintendent. The superintendent fills out the production order, No. 2, as in the case of a general order, with the exception that the number of the order is preceded by the letter "R." This he sends to the foreman, or foremen, who execute it in precisely the same manner as the general order. When the work is completed, the foremen attach their daily time cards and material requisitions to their production order, and return the file to the superintendent, who attaches the original repair order and forwards all to the cost clerk. He fills out both repair order cards—that is, the one that has been handed him by the superintendent, and the one that has been retained by the general manager. He then hands the one he has received from the superintendent to the shipping clerk. When shipment has been made, the shipping clerk makes the proper entries on the repair order, and returns it to the general manager, who files one in numerical, and the other in alphabetical order. The cost clerk then sends the daily time cards, which were attached to the order, to the time keeper, and the requisition orders to the store keeper.



REPAIR ORDER No.________

Date 190

For________ Ship to________

Via ______ Bill to________ Ship______190___

Date shipped 190 Shipping Clerk. Checked by

Please execute the following order and charge all labor and material to the above order.

| Cost of Drawings | Cost of Patterns | Cost of Material | Cost of Labor | Cost of Sundries |
|---|---|---|---|---|
|  |  |  |  |  |

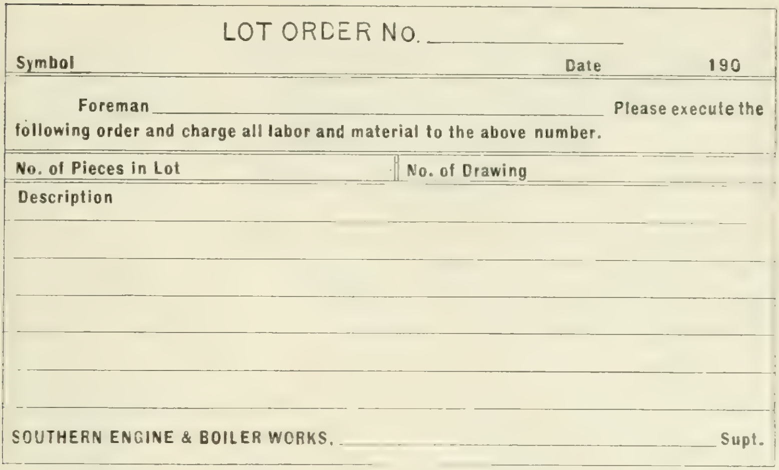
Prime Cost________Shop Expense Add ___% Total Cost ________

Contract Price for the above $ Profit $

SOUTHERN ENGINE & BOILER WORKS ________ Gen. Mgr. Punch

FORM 8. REPAIR ORDER. 6 BY 4 INCHES, BUFF CARD.

It is the duty of the superintendent to issue lot orders for all lots of standard parts of standard machines. This he does by issuing Lot Order, No. 9, in duplicate. One of these he sends to the foreman of the department in which the work is to be executed, and the duplicate he retains on temporary file. The foreman handles this order precisely as he would a production order; that is, he issues the necessary requisition orders, No. 3, and when the lot is completed, attaches



LOT ORDER No. ____________

**Symbol** **Date** 190

**Foreman** ____________ **Please execute the following order and charge all labor and material to the above number.**

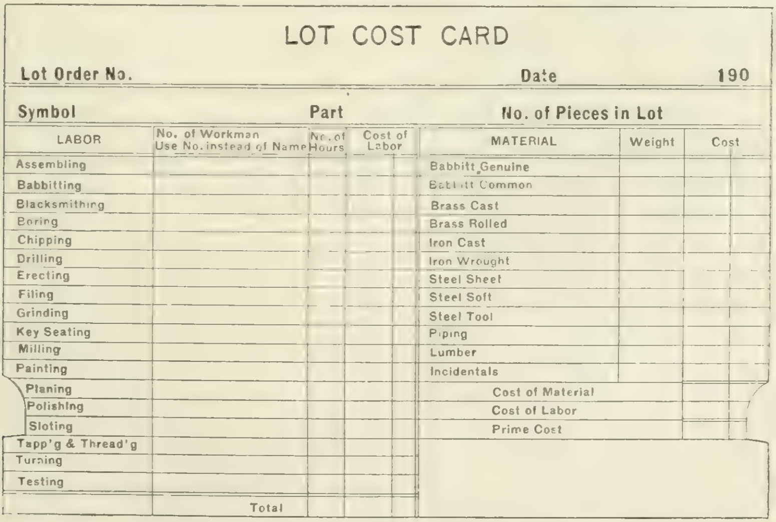
**No. of Pieces in Lot** **No. of Drawing**

**Description**

**SOUTHERN ENGINE & BOILER WORKS,** ____________ **Supt.**

FORM NO. 9. LOT ORDER. 5 BY 3 INCHES, BUFF COLOR, THIN PAPER.

material requisitions and daily time card, No. 6, to the lot order, and returns them with the completed lot, to the superintendent, who inspects the work and forwards the completed lot to the stock keeper, who again checks the work and places the pieces in their bin. The superintendent hands the lot order, with time cards and requisitions, to the cost clerk, who fills out a Lot Cost Card, No. 10, and Comparative Lot Cost Card, No. 11, for the superintendent, who has ready for reference the cost of labor and material entering into each lot;



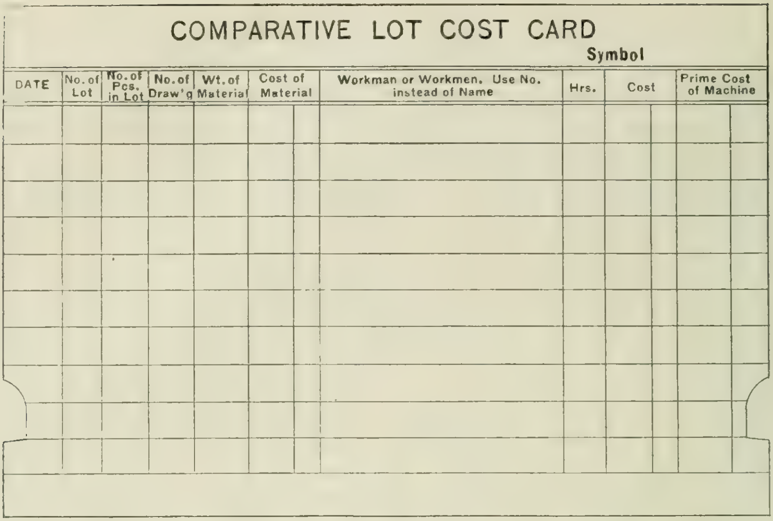
LOT COST CARD

**Lot Order No.** **Date** 190

**Symbol** **Part** **No. of Pieces in Lot**

| LABOR | No. of Workman Use No. instead of Name | No. of Hours | Cost of Labor | MATERIAL | Weight | Cost |
|---|---|---|---|---|---|---|
| Assembling | | | | Babbitt Genuine | | |
| Babbitting | | | | Babbitt Common | | |
| Blacksmithing | | | | Brass Cast | | |
| Boring | | | | Brass Rolled | | |
| Chipping | | | | Iron Cast | | |
| Drilling | | | | Iron Wrought | | |
| Erecting | | | | Steel Sheet | | |
| Filing | | | | Steel Soft | | |
| Grinding | | | | Steel Tool | | |
| Key Seating | | | | Piping | | |
| Milling | | | | Lumber | | |
| Painting | | | | Incidentals | | |
| Planing | | | | Cost of Material | | |
| Polishing | | | | Cost of Labor | | |
| Sloting | | | | Prime Cost | | |
| Tapp'g & Thread'g | | | | | | |
| Turning | | | | | | |
| Testing | | | | | | |
| | Total | | | | | |

FORM 10. LOT COST CARD. 6 BY 4 INCHES, WHITE.



COMPARATIVE LOT COST CARD

Symbol

| DATE | No. of Lot | No. of Pcs. in Lot | No. of Draw'g | Wt. of Material | Cost of Material | | Workman or Workmen. Use No. instead of Name | Hrs. | Cost | | Prime Cost of Machine | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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FORM 11. COMPARATIVE LOT COST CARD. 6 BY 4 INCHES, WHITE.

any variation in cost of production is at once noted and investigated. The cost clerk sends the daily time cards, which accompany the lot orders, to the time keeper for checking the time register, as above stated. All requisitions are returned to the store keeper, who files them in proper order. The cost keeper also places the average cost per piece of each lot over their respective bins, using a cost mark for this purpose.

In the above system the following conditions necessary for a precise, simple, and effective system have been fully met:

First.—All business entering and leaving the shop passes through the hands of the general manager.

Second.—There is a check upon every man in the shop, and upon every man in the accounting department.

Third.—Every man's duty has been clearly defined, and the responsibility for each movement, or operation, has been placed upon one man only. There can be no shifting of the responsibility for the delay or error in executing an order.

The perfect simplicity of the system, so far as pertains to the heads of the different mechanical departments, is evidenced by the fact that the several foremen are in possession of but two cards—*i. e.,* they issue but two—material requisition, No. 3, and daily time card, No. 6, and these are used in precisely the same way in executing any order they may receive; that is, the three orders—production, lot, and repair orders—are executed and disposed of in precisely the same manner by the foremen. The foremen have no permanent records to keep.

# FOUNDRY MANAGEMENT IN THE NEW CENTURY.

*By Robert Buchanan.*

## IV.—SPECIFICATION AND PURCHASE OF COKE, IRON, AND SAND.

**Mr. Buchanan's first article appeared in our issue for December and dealt with the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant. His second paper discussed crane service for the foundry floor; his third, moulding by hand and by machine. The next will take up the management of the cupola.—The Editors.**

THE purchase of materials to best advantage for use in the foundry demands special knowledge in the buyer which is sometimes, but not always, present. When a trained foundryman is in full control of the foundry, purchasing as well as manufacturing, special knowledge of foundry requirements is always present; but he may lack the special acumen and knowledge of markets possessed by a professional "buyer" devoting his whole time to the business of buying.

Where a buyer devotes his whole attention to buying, and the materials bought are subject to the approval or disapproval of the one who is responsible for the working up of the raw materials into the saleable casting, there probably is found the best combination of qualities by which good and economical buying may be effected. The buyer seeks for low prices, and if unchecked is apt to make the invoiced prices of materials the only thing worth considering. The user of the materials has to see that the low prices of the buyer do not run up his costs in other directions and so prove to be a delusive gain. On the other hand, if the user of the materials asks for higher priced goods he should be called upon to give reasons for his demand. A prejudice is not enough. An objection to certain goods, if well founded, will in the very great number of cases be demonstrable by reference to facts and figures cropping up somewhere in the course of manufacture. The system to which I have referred forms a very effectual barrier to either buyer or user serving personal ends by purchasing or recommending goods of low value at a high price.

The businesses which are large enough to employ a buyer who does nothing else are, however, comparatively few in number compared with those where buying is only a part of the duties of the employer, foundry manager, or other responsible person. Whoever he be, it is desirable that such considerations shall prevail and such tests be made as shall take the purchase of materials away from the influences of prejudice into the cooler atmosphere of reason and of fact.

Purchase of Pig Iron.—The branding of pig irons with names, usually those of the district in which the blast furnaces were situated, was and is useful, inasmuch as it forms a means of readily ascertaining the furnaces from which each make of iron comes. By-and-bye the brand was taken to indicate more than the furnace or district of origin. It came to be considered as conveying an idea of certain qualities as belonging to irons of the particular brand. That these irons did have these particular qualities in some measure there is no reason to doubt. The extent of the variation of quality was not readily determined, but that such variation existed there is also no doubt. Most foundrymen are bondsmen to certain brands of iron because they know that with these irons they may look for certain qualities with a fair amount of certitude. From these brands they do not dare to stir. It is high time that foundrymen tore themselves away from the idea that quality of iron arises from anything beyond what is produced by the fuel used, the method of smelting employed, the ores smelted, and the resulting constituents in the pig iron so made.

To the founder the methods used in smelting and the ores charged into the blast furnace are of only slight interest, but the constitution of the resultant iron is to him of the first importance.

When the seller of pig iron produces a small piece, the newly fractured face coruscating with beautiful large crystals of iron, he is apt to look glum when told it is largely a matter of slow cooling and indicates little of what the iron really is. We smile at the idea of the man who shewed a brick as indicating in some degree the kind of house he had to sell. The man who goes about with a piece of pig iron has more reason for his proceeding, as people take him seriously and buy the pig iron. In saying so it is not desired to minimise the information which fracture gives regarding the quality of iron. Fracture does in some measure indicate quality. Hematites, grey foundry iron, mottled iron, white iron, can each and all be identified by fracture; but the causes which produce the particular appearances are inherent in the constituents common to all, but varying in quantity and arrangement. So is it that we require something which shall tell us the amount of the various constituents present with some degree of exactitude. Thus we may use irons of varying characteristics, blending them into one of fairly definite quality. Chemical analysis is of course the means to adopt for a more thorough knowledge of pig iron, and becomes an important aid to a true judgment of the value of the particular iron under review and possibly to be purchased. It is really an added sense of perception.

People selling pig iron as a rule prefer selling by fracture, and some of the salesmen have the haziest notion of what their iron really is. This explains the calmness with which sometimes they quote prices for ordinary pig irons which would be reasonable were hematites under consideration. With analysis as a guide every pig iron may be properly classified as to value. Often special lots may be bought favourably, owing to some occurrence at the blast purchase causing the iron to be "silky" or siliceous. How to use these irons advantageously, and also the effect of silicon and the other constituents present in pig iron, will be considered in treating of the cupola.

In British pig irons the percentage of phosphorus has the closest possible relation to price. A high price may be paid for irons high in phosphorus as a result of bad buying, but irons low in phosphorus cannot be bought cheaply. This is due to the high cost of hematite ores, the scarcity of which, from present appearances, is likely to make irons low in phosphorus gradually increase in value. Careful observation shews that with good buying, taking say 1.2 per cent. of phosphorus as a starting point, and using analysis as a guide, every lessening of the percentage of phosphorus by about one-third of one per cent. costs over two shillings more per ton of pig iron purchased.

Sulphur should not be over 0.05 per cent. Manganese up to 2 per cent. is permissible, but such an amount is too high unless at the same time other irons are used which are low in manganese. For soft castings total carbon should be the highest obtainable. It is seldom over 4 per cent. Silicon may vary from 1.5 to 3 per cent., the former for heavy castings, the latter for light castings.

When the pig iron maker or merchant offers pig iron for sale, he should be made to quote analysis as being quite as important as price. If both be suitable and purchase be agreed to, the purchaser should see when deliveries are made that the quality is as promised. This he can do by taking borings from the fractured surface of six pigs taken from different parts of the consignment. If an agreement be made with a metallurgical chemist the cost of the necessary analysis is small compared to the advantages secured. It will probably be found best to arrange for a certain number of analyses to be made in the course of six months or a year. The number will depend upon the size of the business and the thoroughness with which the system is employed.

Sand Allowance.—This is an allowance which pig-iron makers in many cases are very loth to recognise, but which may legitimately and fairly be insisted upon by the foundrymen. That much sand adheres to the pigs every one is aware. If pig iron is delivered per net ton of 2240 pounds, then the founder is not getting what he bought. He wants iron and iron only, if the pig-iron people would be so good as give him that. Makers of pig iron find it best for them to run the pigs onto sand beds. Until the machine-casting of pig iron is perfected and purchase by fracture has been superseded, they are likely to continue doing so. The foundryman wants iron, not iron and sand. Yes, the sand helps to flux the cupola; but when the foundryman is face to face with the difficulty of fluxing the cupola, he will manage sand enough for fluxing purposes at something under sixty or more shillings per ton. Often the foundryman is soothed by a single pig being added on top of the net weight in the railway wagon, but six tons of pig iron carry more than one hundredweight of sand on them. Some firms who recognise "sand allowance," give it to the extent of 28 pounds per ton of pig iron. Others have a "sand allowance" column in their "delivery notes," giving 1½ per cent., and foundrymen should insist on this allowance being more generally recognised and given. Seeing that in a purchase of 100 tons of pig iron the sand allowance equals 25 hundredweight, if 28 pounds per ton be allowed, the consideration of getting or not getting it ought to have a very great influence in deciding which iron to purchase, other things being equal. If sand allowance be not received, the manager or superintendent of the foundry is certain to be short in his stock of pig iron. Such shortage is usually accounted for by putting it down to excessive loss in melting. No one can make castings from sand, nor from the mixture of sand and iron which forms the skin of pig iron. These form slag and slag only. The legitimate loss in melting is and ought to be quite outside the loss due to sand on, or combined with, pig iron.

Accurate weighing of the pig iron as it enters the works, and accurate taring out of the wagon or truck, is the only way to assurance that the sand allowance is being received. It is not enough that it appears on the delivery notes.

Purchase of Scrap Iron.—Many firms engaged in making light castings do not buy scrap. Their own foundry scrap is sufficient for their purpose. Most foundries making heavy castings buy in scrap, often using considerable proportions in the cupola charges.

In buying heavy scrap one has to consider the breaking up into handy pieces for the cupola. Some recognise a relation of value between pig and heavy scrap iron as being equal to a difference of 5 or 6 shillings per ton. This is not enough. Scrap iron is often rusty and dirty, takes more breaking and handling than pig iron, has a less definite composition, and is subject to more wasting in the cupola. Burnt iron is dear at almost any money and is fit for only the very commonest and cheapest castings. The oxide on burnt iron readily combines with the lining of the cupola, forming a very fusible slag. So where burnt iron is used there is found a great wastage of iron, a great wastage of the cupola lining, copious slag, and weak castings having excessive shrinkage. The excessive shrinkage is due to the low total carbon, which in one sample of burnt iron was only 1.143 per cent. Heavy machinery scrap is much sought after. It has the advantage of having less rust and dirt about it for the weight of iron bought than medium or light scrap has. Many foundrymen deceive themselves as to the virtues of heavy scrap, and have the idea that when mixed with pig iron it produces softer castings than light scrap will in similar conditions. Some heavy scrap may do so, but the greater part will not. A comparison of the silicon contents of both will shew this. Heavy scrap has seldom over 2 per cent. of silicon; medium and light scrap seldom have so little as 2 per cent., and it often goes up to 2.75 per cent. As silicon is a softening agent the point is obvious. Light scrap has the highest phosphorus, sometimes as much as 1.6 per cent., and not often under .90 per cent. in miscellaneous medium and light scrap. Sulphur in scrap of any kind is very seldom under .09 per cent. and a safe average to calculate on is .11 per cent. The kind of scrap to buy will depend on:

(1) The quality available.

(2) The class of castings manufactured.

(3) The pig irons available to counterbalance the particular defects of the scrap.

(4) The skill with which the defects in opposite directions of scrap and pig iron are made to neutralise each other, and so form a suitable mixture.

Purchase of Coke.—The qualities required in foundry coke are a high percentage of carbon, low percentage of sulphur and ash, and considerable density of structure; that is, it should be a heavy coke. Coke having 90 per cent. carbon is satisfactory so far as carbon is concerned. Carbon of 91 per cent. may occasionally be met with; 92 per cent. is rarely obtained. For foundry purposes coke having carbon under 86.5 per cent. should not be purchased. The shortage in carbon is made up by an increase of ash, or worse still, of sulphur. When using coke low in carbon an increased quantity is required. The increased ash requires more fluxing; the increased fluxes require to be melted, and so the waste goes on. High-carbon coke is the cheapest in the end, and it is the business of the foundry manager or foreman to prove it so by practical results.

Ash in foundry coke ranges from between 6 and 7 per cent. to over 10 per cent. As already stated, ash usually takes the place of carbon, when the latter is deficient. The difference between a coke of 6.52 per cent. ash and one of 10.30 per cent. is over 84 pounds of ash per ton of coke. When it is considered that that 84 pounds should be carbon which will do melting, instead of ash which itself has to be fluxed and melted, it is easy to see that the coke with 10.30 per cent. ash at one shilling per ton less in price than the other is a bad bargain.

Sulphur in foundry coke ranges from 0.53 per cent. to over 1 per cent., and the average is a little over 0.75 per cent. in good coke. Sulphur should be jealously watched, its hardening effect upon the castings is so great.

When purchases of coke have to be made, the makers or merchants should be asked to quote on a basis of supplies not falling under or over the following percentages:

Carbon not to be under 88 per cent.
Ash not to be over 8 per cent.
Sulphur not to be over 0.75 per cent.

Coke having carbon under 86.5 per cent. is to be rejected. As coke is carried in open trucks, and so is subject to the rainfall during transit from the coke-ovens to the foundry, excess moisture is difficult to guard against. In summer the moisture should be under 1 per cent.; in winter it will readily be over 3 per cent. After a night's rain it has been observed that the coke on the top of a truck contained as much as 7½ per cent. of water. The lighter the coke the more water it will take up, as might be expected.

(a) One cubic inch light coke which weighed dry 172.25 grains, when saturated gained 7.9 per cent. of water.
(b) One cubic inch heavier coke which weighed dry 213.50 grains, when saturated gained 6.6 per cent. of water.
(c) One cubic inch heavy coke which weighed dry 298.50 grains, when saturated gained 2.3 per cent. of water.

The density and hardness of coke are very important. A dense or heavy coke has the particles closely and firmly adhering together and so it stands without decrepitation the impact of the falling iron charged into the cupola. It must also sustain the weight of the

BEEHIVE COKE OVENS, ACCRINGHAM, ENGLAND.

charges of iron, and withstand the action of the blast, while in an incandescent state of heat, until dissolution takes place by the combustion of the carbon. Foundrymen can usually tell very nearly the quantity and density and hardness of coke by simply handling it, but they must rely upon the chemist for exact percentages of carbon, ash, and sulphur. The knowledge that exact methods for ascertaining the constitution of the coke are employed goes a great way in obtaining the quality desired. Merchants endeavour to supply what is required, and let the lower qualities go to users not in a position to test supplies except by using them. In the latter case no one can readily decide whether it is the coke or the mode of using it which is at fault.

A simple test for density may be made if one has a laboratory scale as illustrated on page 886. Take a small piece of the coke to be tested, grind it on the emery or other abrasive wheel to a one-inch cube. Thoroughly dry it at a temperature not exceeding that of boiling water; then weigh. A cubic inch of coke of fair density weighs 230 to 240 grains when free from moisture. This test for density is a very simple one, puts on a proper basis which has hitherto been merely an assertion, on one side or the other, and is dependent on no previous scientific training or experience. A rough test for density may be made by dropping a piece of coke into water. If it floats it weighs less than 253 grains per cubic inch. If it sinks it weighs more than 253 grains per cubic inch.

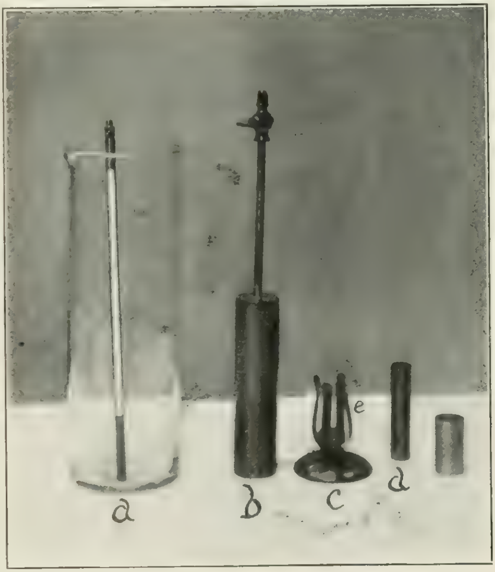
A FOUNDRY LABORATORY SCALE.

In the United States coke is designated "72-hour coke" or "48-hour coke," the terms indicating the time the coal is undergoing the coking process, and being used to express quality. These terms are not used in Great Britain. The only reliable tests for quality are chemical and physical tests, supplemented by the test of amount of iron melted per pound of coke used. Here the personal element comes in, but it is not likely to cause trouble if once it is clearly understood at the cupola that the one at the head of affairs has an accurate knowledge of the quality and condition of the coke. Indeed, good results are more likely to be obtained, as carelessness, neglect, or waste can be located at once and the cupola man knows it.

Fluxes.—Every foundry requires fluxes for use in cupola melting, unless the melt be of a very modest character indeed. Even then it will be more profitable to use a flux. When a flux is not present iron has a most unhappy way of taking its place in the slag. Limestone is the flux which is in almost universal use. In a few places, owing to local conditions, oyster shells, chalk, or marble chippings may be used, but in every case it is the basic quality of lime which is utilised. Fluorspar is sometimes used as a flux either by itself or in conjunction with limestone. Limestone only will be considered now, and fluor spar when the cupola comes under review. Limestone should have the greatest amount of calcium carbonate obtainable. In limestone of good quality this will amount to about 98 per cent., the remaining 2 per cent. being small percentages of magnesia, alumina, silica, etc. Should silica be present in any appreciable degree, and it sometimes reaches over 4 per cent., the quality is depreciated accordingly. The silica present in the limestone takes up just as much of the calcium carbonate as will flux it, and so there is a double loss, and the slag is also increased in quantity. It will be found in most cases advantageous to buy limestone broken ready for use. This costs very much less in the end than buying limestone lumps. These take a deal of breaking by hand, and they are not broken so small as is done by the stone-breaking machine. The smaller the pieces of limestone the more suitable they are for cupola use, so that they be just large enough not to be blown away by the blast.

Purchases of Refractory Materials.—These include fire-clay, fire-bricks and ganister. Fire-clay is usually described as being a hydrated silicate of alumina, that is, it is a compound of silica and alumina with some water in the combined form. Any other bodies present in addition to those act as impurities and so lower the point of temperature at which fusion takes place. This is especially true of soda or potash, and in a less degree, of oxide of iron and lime. The greater the proportion of alumina the less fusible fire-clay is and the less subject to the cutting action of slag. Fire-clay is plastic in proportion to the fineness of the particles and percentage of alumina. The principal objection to fire-clay is the great shrinkage which takes place while passing from the plastic to the burnt condition.

Where analysis is inconvenient or not available, a simple test for fusibility may be made if one has a pot furnace such as brass founders use. Form a portion of the clay into a small pyramid having sharp angles and apex. Dry the pyramid with a gentle heat, then place it in a small crucible, lute on the lid with a little fire-clay of known good quality, and subject the crucible to a good strong heat for an hour or more in the pot furnace. If only of fair quality the pyramid will show signs of fusion. If of bad quality, instead of a pyramid the clay will be a formless mass.



THE CALORIMETER AND ITS PARTS.—SEE PAGE 890.

The following analysis from Greenwood's "Steel and Iron" may be taken as an example of good fire-clay:

STOURBRIDGE FIRE-CLAY.

| | Per çent. |
|---|---|
| Silica | 63.30 |
| Alumina | 23.30 |
| Potash | —— |
| Soda | —— |
| Lime | ·73 |
| Magnesia | —— |
| Ferrous Oxide | 1.80 |
| Water combined<br>" Hygroscopic<br>Organic Matter | 10.30 |
| | —— |
| | 99·43 |

Ganister.—Ganister is a refractory material much used for "fettling" and repairing cupola linings. It is composed principally of silica with a small percentage of alumina as the binding material. It is less plastic than fire-clay but does not crack so readily when heated. Like fire-clay it should be free as possible of soda, potash, lime, and oxide of iron. A test for fusibility may be made exactly as for fire-clay. Analyses of three samples are given on the opposite page.

No. 1 was the best of the three in actual work. No. 2, notwithstanding its purity and high percentage of silica, was the least satis-

SIMON-CARVE COKE OVENS, ALTHAM COLLIERY CO., ACCRINGHAM, ENGLAND.

factory, wasting and forming most copious slag. This shews that however satisfactory such a material would be in a position away from the action of basic slags and oxide of iron, ganister with silica over 94 per cent. is useless at the melting zone of a cupola. What it wants is a greater percentage of alumina.

ANALYSES OF GANISTER.

| | (1) Welsh Ganister. Per cent. | (2) Welsh Ganister. Per cent. | (3) Sheffield Ganister. Per cent. |
|---|---|---|---|
| Silica | 84.54 | 94.70 | 86.48 |
| Alumina | 7.78 | 4.27 | 4.57 |
| Oxide of Iron | 4.85 | 0.78 | 3.43 |
| Lime | 0.13 | Trace | Trace |
| Magnesia | —— | Trace | —— |
| Loss on calcination | 2.68 | —— | 5.46 |
| | 99.98 | 99.75 | 99.94 |

Fire-Bricks.—These have as a first necessity the quality of not softening at a high temperature. In the second place they must not disintegrate or chip under the influence of heat, and they should not be readily fluxed by the slags running down them. Excessive expansion and contraction are causes of objection as likely to cause a shorter life to the cupola or furnace lining, and fire-bricks for cupola use should be able to withstand quick changes of temperature from the highest melting temperature to the normal temperature of the atmosphere without excessive cracking. That fire-bricks combining these qualities to a very satisfactory degree are available says much for the excellent materials used and mode of manufacture employed.

The following analysis is that of fire-bricks noted for their non-expansion under high temperatures, as well as for the usual qualities to be found in fire-bricks of high quality.

| | Per cent. |
|---|---|
| Silica | 62.10 |
| Alumina | 33.10 |
| Ferric Oxide | 3.00 |
| Lime | 0.90 |
| Magnesia | trace |
| Potash | 0.90 |
| | 100.00 |

Purchase of Coal.—The quality of coal which is bought for firing boilers or for the stoves or ovens in which moulds and cores are dried depends upon the carbon present and also upon what is termed "the available hydrogen." All coals contain oxygen and hydrogen, and when combustion takes place these two elements combine in the proportion of two atoms of hydrogen to one of oxygen and so form water vapour. When the oxygen present in the coal has all been so combined, the hydrogen which is in excess is of high calorific value and being burnable is called "the available hydrogen" as stated. Thus if two coals have equal percentages of carbon the one with the most "available hydrogen" will be the better of the two.

The calorific intensity or heat-giving quality of coal may be ascertained and measured by means other than the quantitative analysis of the constituents. By means of the "calorimeter" the total heating effect of carbon and hydrogen present may be measured rapidly and accurately. Fortunately the "calorimeter" is simple to use even by those having no training in the use of scientific instruments.

The following description and method of using the calorimeter is from Hiorns' "Practical Metallurgy and Assaying." The apparatus consists of a tall glass cylindrical vessel (a) capable of holding 60,000 grains of water. (The vessel shown on page 887 contains about 40,000 grains.) At a given height a mark is scratched on the outside to indicate 29,010 grains of water, which equals 967 × 30 (the former figure being the latent heat of steam, and the latter the weight of fuel taken). A copper vessel (b) is fitted at the top with a stop cock; and a perforated stand (c) into the socket of which the copper crucible (d) fits. The stand has four springs (e) for keeping the cylinder (b) tightly fixed to the stand.

> "To determine the calorific power of a given fuel, carefully dry a quantity of finely powdered potassium chlorate, and nitrate, in separate dishes. Also a quantity of the fuel very finely powdered should be dried for half-an-hour at least in a water oven. (Note. It may be dried anywhere so that the temperature does not exceed that of boiling water.)
>
> "Weigh out 30 grains of the dried coal, 225 grains of potassium chlorate, and 75 grains of nitre, mix well and introduce into the perfectly dry copper tube of what is known as Thompson's or Wright's calorimeter. Ram it moderately tight, insert a small piece of fuse (prepared by soaking cotton wick in a solution of nitre and drying it) and place the tube in the stand ready for the experiment. Now take the temperature of the water in the large vessel; light the fuse; cover with the bell tube (b) taking care that the tap is closed, and put the whole in the water before the ignited fuse has had time to burn down to the mixture. When the combustion appears complete, open the tap so that the water may absorb the residual heat in the tube; and again take the temperature of the water. The increase of temperature plus 10 per cent. added for loss gives the evaporative power of the fuel.
>
> EXAMPLE.
>
> | | |
> |---|---|
> | Temperature of water before the experiment......... | 55°F. |
> | Temperature of water after the experiment........... | 66°F. |
> | Temperature produced by the combustion............ | 11° |
> | Plus 10 per cent. ................................ | 1.1° |
> | Total evaporative effect ............................ | 12.1° |
>
> *i. e.*, 1 pound of the coal on perfect combustion will generate 12.1 pounds of steam.
>
> "The calorific value of fuel may be estimated in "calories" or in vapour units. The calorie represents the heat absorbed by the unit

> weight of water when its temperature is raised one thermometric degree, the centigrade scale being most generally employed. The vapour unit was proposed by Rankine and corresponds to 537 calories if the centigrade scale be used, and 967 calories for the Fahrenheit scale. In order to express calories in vapour divide by 537 or 967 respectively. To convert vapour units into calories multiply by these numbers. Take the example given, viz., 12.1 vapour units; 12.1 × 967 = 11,700.7 calories."

To prevent misapprehension it may be stated that the potassium chlorate and the nitre do not themselves provide any heat; they merely supply oxygen for the combusion of the fuel while the latter is cut off from the oxygen of the air. The crucible (d) is used for long-flaming coal containing hydrocarbons, the shorter crucible is used for anthracite.

Coal for Making Coal-Dust—As already stated, a long-flaming coal containing not less than 36 per cent. of hydrocarbons, and fairly low in ash, is best. Unless a founder is sure of his dealer he should make his own coal dust. One place manufacturing coal dust for general sale, found a ready outlet for the boiler clinkers by getting confiding foundrymen to buy them ground up in the coal dust. Fifteen or twenty shillings per ton for boiler refuse is not at all bad business for the seller,

It is often possible to buy fine dust or very small coal from the collieries, and to get it cheaper and have it in better condition for grinding than if it were large coal.* Only it must be clean and free from dirt and rubbish. Whether buying coal dust ready ground, or buying coal and making it oneself, it is not difficult to check the percentage of ash present, whether there by nature or by the guile of man. If one has a chemist available, good and well; but failing the trained chemist the following is a practical and accurate test which may be made by anyone:

The apparatus consists of a laboratory scale, two small porcelain roasting dishes, a sheet of glazed paper, a pair of light tongs, and a muffle. A complete muffle heated by gas may be had from any firm that supplies materials to laboratories, but a cheap muffle to burn coke is shewn on page 892. The only part requiring to be specially purchased is the ⌓-shaped muffle shewn built in. The remainder consists of ordinary fire-bricks and a cast-iron grating. The muffle is connected to a chimney.

If the coal dust is newly ground it will contain little moisture, but it is well to put all samples to be tested where they will be dried at a temperature not exceeding that of boiling water. Two pieces of the

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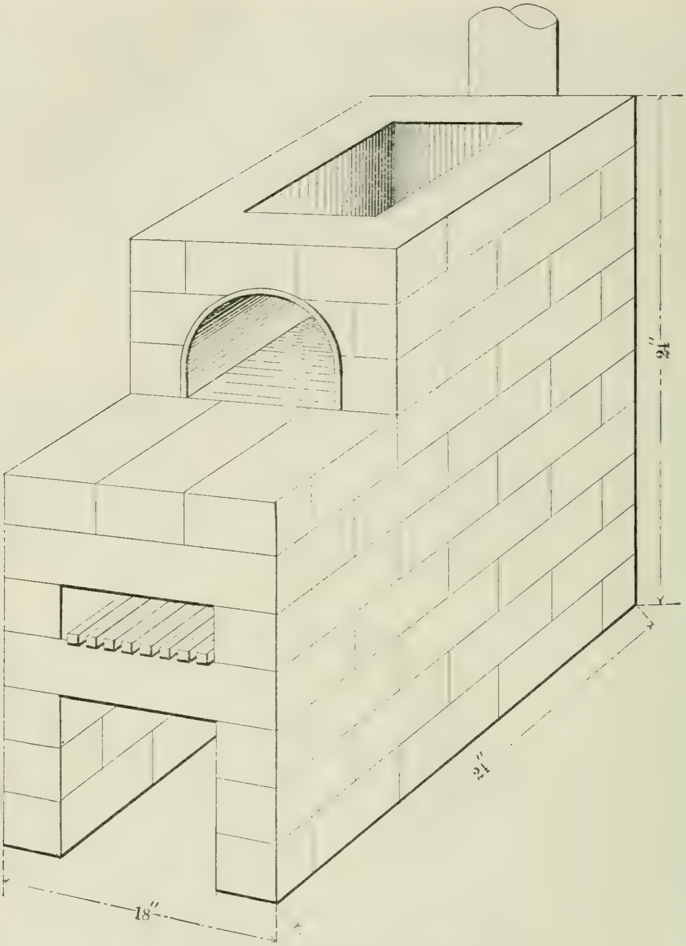
* It should be noted that finely ground coal, especially of certain sorts, is subject to spontaneous combustion. Care should be taken not to store it near wooden partitions, posts, or combustible materials.—THE EDITORS.



MUFFLE AND MUFFLE FURNACE.

glazed paper are made to exactly balance each other and on one of these make two separate and accurate weighings of 50 grains of the coal dust. Each weighing is transferred from the glazed paper to one of the roasting dishes, and the two roasting dishes are put in the muffle where they are kept for an hour or longer according to the heat. At the end of an hour take out one dish and allow to cool. Weigh the ash by brushing it onto the glazed paper. Note the weighing, return the ash to the roasting dish and re-insert in the muffle for fifteen minutes. When cool, weigh again, and if the weight is as before then the carbon has been completely burnt. The contents of the two roasting dishes act as a check on each other. Seeing that 50 grains was the quantity taken, if 6 grains of ash be left then the ash equals 12 per cent. If preferred, instead of weighing the coal dust on the glazed paper take the weight of each roasting dish and weigh the 50 grains in it and proceed as shewn, deducting the weight of the roasting dish* after the final weighing. However formidable this may look, it is really a simple operation and may be applied to the testing of coal by reducing a few ounces to a fine powder and proceeding as detailed.

Testing for ash supplies a complete check upon the seller of coal or coal dust; one has an assurance that he is getting the best materials for the facing sand, and value for the money paid. In addition, should castings turn out rough, the moulder is debarred from blaming "the bad coal dust "as being the cause of the trouble.

Purchase of Blackings and Facings.—Charcoal, and "patent" blackings—that is, blacking made of carbon from oil or gas retorts—are not so subject to adulteration as plumbago is, the high price of the latter rendering it very liable to the attention of the people who desire to cheapen it by mixing impure and cheaper materials with it. When a heavy plumbago is offered at say one penny per pound it is just as well to realise that it is a product of very low quality. The price indicates the amount of incombustible material present. This in one case amounted to 62 per cent. Good quality plumbago should contain under 20 per cent. incombustible material. Buy good quality and use it sparingly, rather than low quality used lavishly.

The test for ash as used for coal dust may be applied to plumbago. It requires, however, a much more prolonged exposure in the muffle than for coal, but will be found worth the trouble. Plumbago is sometimes called "silver-lead." Being neither silver nor lead it is a singularly unhappy name. Plumbago is got in the earth, is believed to be of vegetable origin like other carbons, but retains no trace whatever of vegetable structure. Good plumbago is of a bright grey colour, has a "soapy" feel when rubbed between the fingers, having no grittiness. Its high qualities as a material for making smooth castings appear to be due to its high specific gravity and also to the resistance the condition of the carbon offers to vaporisation by the heat of the molten iron.

Charcoal blacking is best made of the heavier woods, such as oak, and even then it is an objection that charcoal blacking, owing to its lightness, readily washes before the metal. It is quite unsuitable for dry-sand moulds. If it is desired to give weight or body to charcoal blacking an addition of 10 per cent. of plumbago acts in the desired direction, helps to give a good skin to the casting, and facilitates the "sleeking" of the mould. The addition of "patent" or retort-carbon blacking gives weight to the compound but makes sleeking more difficult where green-sand moulds are concerned. Charcoal blacking has usually less than 1 per cent. of ash, but patent or mineral blackings vary from 30 per cent. to 49 per cent. of incombustible matter. The skin desired on a casting may thus be obtained by actual contact of metal and carbon as supplied by blacking, or by hydrocarbons as obtained from coal dust or by a combination of both. Neither of these will make a nice casting of a badly finished mould.

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* This is the preferable method. Paper is so hygroscopic that error may be introduced by changes of weight due to absorption, or loss, of moisture between weighings.—THE EDITORS.

Moulding Sand.—The colour of moulding sand is of no importance. When the sand is red the colour is due to ferric oxide. In yellow sands the colour is due principally to the alumina present. The ferric oxide, however, gives a strong red colour if fully 2 per cent. be present, although there may be over 6 per cent. of alumina, shewing the red oxide of iron to be a powerful colouring agent. Oxide of iron when present as one of the constituents of moulding sand is said to have the power of assisting to put a skin on the casting. If it is so the reason is not clear. It should not be over 5 per cent., as every increase makes the sand more fusible. From 2 to 2¾ per cent. of oxide of iron will be found a suitable quantity.

Alumina may vary from 3.70 per cent. to 5 per cent.—certainly not a wide range. A sand containing 6.34 per cent. of alumina gave trouble by "scabbing" the green-sand moulds, when mixed with black sand in the usual proportions. Sand having 9 per cent. of alumina may be used for dry-sand moulds but is apt to cause cracks in the mould when drying. There should not be any lime, potash, or soda present, as these increase the fusibility, as already mentioned in the case of ganister. Moisture should not exceed 2½ per cent. at most. When moisture reaches 6.10 per cent. in a sand costing over 10 shillings per ton, one is apt to conclude that art has triumphed over nature by means of a water bucket.

Tests for Fineness.—These are made by having sieves of various sizes of mesh, beginning say with 100 to the inch and gradually increasing the size of mesh. A certain weight of sand is weighed or measured and the degree of fineness is gauged by the quantity which passed through each sieve, beginning with the finest, when a certain number of shakes are given. In most cases, however, it will be found that cost of transport is the determining factor as to fineness of sand bought. Certain percentages of silica, alumina, etc., must be present before it can be considered to be moulding sand, but fineness may be obtained by mechanical treatment in pan mills, or other suitable means. Everyone would buy moulding sand of proper fineness were that always obtainable from the nearest sand banks, or sand pits. When cost of transport for the naturally fine sand exceeds the cost of making fine mechanically, then the latter is the course to adopt.

Storage of Materials.—Pig iron should be piled in blocks of definite form, each grade and brand of iron being distinct. This allows of stock taking of any or all of the irons being made at any time, if it is thought desirable to do so. A monthly stock taking of iron is advisable and quite feasible with a properly arranged pig yard. The cupola records of metal melted will shew how much pig iron of a given brand should be in stock. This is a check against leakage of any kind, if one may apply the term to pig iron. It also prevents collusion by which low-quality irons may be supplied as stock of better quality, should pig-iron maker or merchant be supplying two qualities by agreement with the purchaser. A further check is obtained when the men emptying the trucks and piling the iron give truck numbers, grade, and brand of iron, on which payment is to be made for work.

Storage of Coke.—Coke should, wherever possible, be stored under a roof. Wet coke is considered by some to cause decrepitation in the cupola. It is a reasonable supposition that steam formed in the interior of the coke may so act. It is certainly the case that when coke is wet, if accurate weighing be in use at the cupola, the quantity of burnable carbon put into the cupola will be less than supposed. As nothing can possibly be gained from the water in coke, it is well to have it dry as possible, especially as the coke least able to spare heat will carry the most water, as already shewn.

Fire-bricks should always be under cover, and kept as dry as possible. If they have absorbed any considerable amount of moisture quick application of high temperatures is quick destruction. Often the small service which some fire-bricks give is due more to bad usage than bad quality. If fire-bricks have got wet, a slowly rising temperature which will gradually drive off the moisture is a necessary preliminary to good service.

In the foregoing notes much has been left unsaid, as space will not allow of fuller treatment. In concluding this portion of the subject the author would appeal to the judgment of scientific and honest test as the sole arbiter of what is best to purchase. No buying is so badly done as that which proceeds from bribery. The man who takes secret payment puts himself in the power of one who may one day be his enemy. Nay—he who gives a bribe *is* an enemy, and will have his own again with usury.

# THE BETTERMENT OF STEAM-BOILER ECONOMY.

*By E. S. Farwell.*

The whole animus of modern engineering is economy—of time, of effort, of energy. In studying the advancement of economy, however, we are too apt to confuse our sense of proportion and limit our vision by a close-range contemplation of details. There is sound value and profit in getting back, as Mr. Farwell does in the following review, to the fundamentals—in viewing the elements of the situation largely, and shaping our efforts and studies anew by the main lines, rather than the minor ones, of the problem before us.—THE EDITORS.

IT is often necessary to have some great disaster or trying adversity in order to spur us on to our best endeavors. Nothing in years has aroused in the United States such general interest in fuel economy, as the strike of the past year. This interest is not confined to the industries, but has invaded domestic life. Propositions to save fuel or enable cheaper fuel to be burned in ranges, stoves and furnaces are finding receptive minds and eager investors. With this widespread interest, it will be surprising if American industries do not emerge with a much improved steam plant. It is not the purpose of this article to advocate or advertise any particular device or class of devices, but to indicate some of the most promising lines in which improvement should be sought.

The principles affecting the economy of steam boilers are so simple and well recognized that it seems almost incredible that we have not made more progress than we have during the past century. Notwithstanding all the elaborate experiments and investigations of our scientific men, we still hang the ketttle on the crane, so to speak, and let it absorb what heat it can before the gases go up the big chimney. In school we are taught certain correct principles which we immediately proceed to forget so soon as we are graduated. Some "practical" man tells us that "it may be right in theory, but it will never do in practice." I cannot find polite words to express my condemnation of that statement. If it is right in theory, it is right in practice. To use an expression of the day, it is "up to us" correctly to interpret and apply these unquestionably correct theoretical principles. If our application is a failure, let us manfully admit it is a result of our inability to appreciate the true meaning of the theory. Not until we shall have arrived at this conclusion is there any hope of advancing our profession.

For a number of years no advance has been made in the efficiency of the boiler plant. I am not unaware that this statement will be disputed by inventors and other interested parties; nor do I wish to be understood to say that some of these so-called improvements are not correct in principle, and more or less so in application. I am speaking of the general practice of the day. We still, after many years and the introduction of expensive equipment, find our boiler plant running on 70 per cent. efficiency. What becomes of the other 30 per cent., and how can it be saved? About 1 per cent. is in the ash, 6 per cent. is radiated, and 23 per cent. goes up the chimney for one cause or another. From a scientific standpoint, it is easy to see how to remedy the first two items. It becomes merely a commercial problem, with the saving effected on the credit side, and, on the debit side, the interest on the investment necessary to make the saving.

The causes which produce the loss up the chimney are many and varied. They may be divided into three groups: those relating to combustion, or the production of heat; those relating to the absorption or utilization of heat; and those relating to the movement of the gases through the fuel bed, flues, and chimney, or to the production of "draft." The first consideration should be to produce complete combustion at the highest attainable temperature. Each pound of coal requires a certain known quantity of oxygen for its complete combustion, no more and no less. Yet we have actually come to believe that it is *necessary* to supply one and a half to two times the theoretical quantity of air if we wish to get complete combustion. A double supply of air practically doubles the energy consumed in the draft producer, doubles the amount of heat carried up the chimney, and reduces the temperature of the furnace one-quarter. The problem is to bring each particle of oxygen into close proximity to the particle of fuel to which it belongs. This must be accomplished before the particles are cooled below the temperature of ignition. If the supply of air is limited to the theoretical amount and introduced entirely through the fuel bed, much of the volatile gases will pass off unconsumed and the remaining carbon will only half burn to carbon monoxide. Part of the air, already heated, may be introduced above the fuel bed, through holes in the side walls or otherwise, but that is only half the solution unless this air is properly mixed with the gaseous fuel. Brick checker work and baffle walls have been used for this purpose.

but usually after the gases have been cooled by contact with the shell or the tubes of the boiler. A maze of steam jets has also been tried, with its consumption of energy. The volatile gases, amounting to from 20 to 40 per cent. of the fuel in bituminous coal, are driven off during the first few minutes after the coal is fired; hence, with periodic or hand firing, the supply of air to be mixed with the gases must be variable. With a uniform feed, as in most stokers, the air supply may be practically constant, and that introduced above the fuel bed may be admitted at the most effective point for an intimate mixture. If the fuel is fed in at the front, it will ordinarily give off its volatile gases while traversing the first foot or eighteen inches. These gases may be confined and forced to pass near or through the bed of fire under jets of heated air, thus becoming thoroughly mixed.

The introduction of steam, both above and below the grate, is sometimes thought to add fuel to the fire. But this is never so. In fact, in making up the heat balance, this will always appear as a loss. One use of the steam jet above the grate has already been mentioned; another will be later. Steam admitted below the grate serves a useful purpose in that, by its decomposition, it forms with the carbon of the fuel a water gas which burns in a flame. This merely transfers part of the combustion to the space above the fuel bed, thus reducing the amount of heat generated on the grates. This saves the grates and prevents the melting together of the ashes into a clinker, so that every part of the fuel bed may get its proportionate supply of air.

The space above the fire bed should be devoted entirely to the completion of combustion before the gases come in contact with any cooling surface. The combustion in your gas jet or lamp flame is complete and perfect. Hold a test tube of water in the flame and note the immediate deposition of unconsumed fuel upon it. Hold a coil of wire about a candle flame and watch it go out. These experiments were once known to most of us, yet we placidly set our horizontal tubular boilers 28 inches above the grate and wonder why we get smoke. And as though that was not bad enough, we have in the wonderful strides of progress of the past decade, built water-tube boilers in which the gases and flame rise from the grate and plunge immediately through a twelve-high bank of tubes. I am informed by a maker of both horizontal and vertical water-tube boilers that the former, with the fire directly below the tubes, are more efficient for hard coal, and the latter, with an exterior furnace, for soft coal. The reasons are not hard to find. We are told that radiation is the most efficient method of transmitting heat; hence, the advantage of the horizontal boiler with the tubes directly over the fire. With hard coal having a short flame, combustion is practically completed before reaching the cool tubes. But with soft coal, more is lost in the horizontal boiler by the dampening of the flame than is gained by direct radiation to the tube surface. If a furnace could be devised in which the advantage of direct radiation could be retained while the gases were kept from contact with all cooling surfaces until combustion was complete, we would make a long stride in advance. This result has been attempted by the use of a steam jet in the form of a sheet covering the entire furnace and deflecting the burning gases away from the boiler until combustion was completed.

The transfer of heat from the gases to the water is proportional to the difference of temperature. Having constructed the furnace to produce complete combustion without the dilution of the gases by an excessive amount of surplus air, the gases reach the boiler at the highest possible temperature. The water has a uniform temperature corresponding to the pressure carried. The first square foot of heating surface transfers heat very rapidly, and the last square foot very slowly, since the temperature of the gases has now been very much reduced. When we see that the temperature of the water is 350 degrees, we consider 450 degrees very good for the escaping gases. This is still further reduced by the use of an economizer containing water at an average temperature of 250 degrees instead of 350 degrees in the boiler. I have known of a boiler plant in which the gases from horizontal tubular boilers passed through two sections of an economizer in succession, the combined heating surface of which was equal to that of the boiler. In this plant, when a horse power was being developed from 5 square feet of boiler-heating surface, the temperature of gases escaping from the last section was about 260 degrees. This division of the heating surface is in the direction of economy, but it should be carried to the limit. I have recently seen some literature relative to a boiler which claims to embody this principle. It seems odd, however, to see an inventor going to such extremities to force the heated water to circulate downward. The natural tendency of heated water is to rise, and as steam must be liberated from the surface and sediment ordinarily settles, it would seem that the best results would be obtained by employing rather than antagonizing nature. Another fact which harmonizes with this is that those gases which have become cooled most and settle to the lower level are the ones which should be first discarded. In a large number of boiler tests on vertical boilers having top flue connections, I have seldom observed a temperature of gases leaving the boiler below 600 degrees when running the boiler near rated capacity. It has always been one of the most difficult problems for makers of this type of boiler to prevent short circuiting, and the formation of cold-air pockets. I would suggest that these natural tendencies be taken into consideration; that the heated water be allowed to rise to the top and there converted into steam; that the cooled gases be allowed to drop to the bottom and there drawn off; that the hottest gases be applied at the top to the hottest water; and that the feed water be introduced at the bottom where it will be able to abstract heat from the coolest gases. The water in the bottom of the boiler may be 100 to 200 degrees cooler than the steam, for there need be no circulation and we know that water is a very poor conductor. The effectiveness of the last square foot of heating surface will thus be very much increased, and the temperature of escaping gases should be below 300 degrees at most.

In regard to the third portion of the loss, I can only say that our adherence to the chimney of our ancestors is worthy of a strict Confucian. A fan driven by a steam engine at 6 per cent. efficiency is still far more efficient than a chimney as a draft producer, provided other uses may be found for the heat contained in the gases. As has already been mentioned, this heat may be much reduced by a radical change in the design of our boilers. A further use may be found in heating air or water for warming the buildings, or heating air for combustion.

For an ideal boiler plant, then, we should have a furnace in which the minimum amount of air compatible with complete combustion is thoroughly mixed with the fuel, and combustion is completed before the gases are cooled below the temperature of ignition. The boiler should be so designed as to present at any point in the path of the gases the maximum difference of temperature between the gases and water, and to reject always and only the coolest gases.

# THE BRITISH NAVAL ENGINEER UNDER THE NEW SCHEME.

*By Charles M. Johnson.*

**The struggle for fitting recognition of the naval engineer, not only as a matter of justice but as an essential to naval efficiency, is one in which THE ENGINEERING MAGAZINE has taken an earnest part. It is with very great gratification therefore that we have seen the British navy—the greatest navy in the world—follow the lead of the American navy, and go yet further, in placing the engineer corps on its proper plane of dignity. Some comparison of the British scheme with the United States "personnel law" is made in our reviews this month. Mr. Johnson deals principally with the substance of the scheme and the training and position of the engineer under it.—THE EDITORS.**

THE proverbial long lane has taken a turn at last in the right direction. The disabilities under which the British naval engineer officer has laboured for so many years have at length been acknowledged by the Admiralty not only to exist, but also to militate against naval efficiency. The engineers of the navy have for many long years insisted on this palpable and irrefutable fact, but few would listen —and those who did, did not believe. But what the engineers of the navy were unable to effect, the almost unanimous consensus of opinion declared by the great engineering institutions and journals of the country has succeeded in accomplishing. The engineer officer of the future will have an executive title, executive rank, and—which is most important of all—executive authority; so that, in the words of the late Admiral Charles Fellows: "he will be able to give an order to any man in the ship, without the possibility of its being disobeyed or even questioned." Whether the engineer officer of the future will be as good an engineer as his predecessor, is a question time and experience alone can solve.

The fundamental basis of Lord Selborne's new scheme is that there shall be one system of supply, one sytem of entry, and one system of training. In the opinion of Lord Selborne and his colleagues, and doubtless also in the opinion of the majority of naval officers, this restriction of supply, entry, and training to one source, and through one avenue, will result in producing "a lifelong community of sentiment." That is to say, that all having entered the service by the same door, studied in the same school, and been companions for the first seven years of their naval careers, it may reasonably be expected that there will be a lifelong community of feeling and comradeship, and that the professional jealousies and class prejudices which have never been absent from the navy of the past century will hereafter be "historical reminiscences" only. In fact the "New Scheme" is a bid for universal brotherhood among naval officers of the combatant branches. The end sought to be attained is a desirable one, provided efficiency be not thereby sacrificed. The three branches which are recognised in the scheme as forming the fighting arm of the service are the executive, the engineer, and the marine, and it is with these alone that the new scheme deals.

The mode of entry into the service is to be by nomination, combined with a very elementary and limited competitive examination; and the memorandum goes on to state that "in the nomination of candidates, preference will be given—other things being equal—to those boys whose parents or guardians declare for them that they are prepared to enter any one of the three branches of the service, at the termination of their probationary period of service afloat." The successful candidates will be entered at once at the Royal Naval College, where they will remain under instruction for four years. The curriculum will consist of an extension of the present Britannia course, including elementary instruction in physics and marine engineering, with the use of tools and machines in connection therewith.

I pause here, to note what appears to me to be the weak point in this part of the programme of instruction. What is to be the nature of the factory or workshop in which this engineering instruction is to be imparted? What is the description of plant, machinery, and tools, on which their infantile excursions into the practice of engineering are to be essayed? What is to be the class of work on which they are to be employed? Is it to be work of a nature that may be utilised when completed, or is it to be relegated to the scrap-heap? Who are to be the instructors? These and many other such questions will naturally occur to the mind of every practical engineer, who will readily perceive that the making or the marring of this branch of their first period of instruction depends entirely on the answers given to the above and all kindred questions. Unless the foundation be well designed, laid, and constructed, the superstructure can never be of any permanent value. It appears to me that at the best, the instruction in engineering to be imparted during these first four years must of necessity, from the very nature of the curriculum as a whole, be of an essentially perfunctory nature; but if the Admiralty wisely determine that this portion of their programme shall be drawn up by engineering experts, and, as far as possible, adhered to without alteration or modification, there will be every reason to anticipate that engineering will occupy its rightful poition in the education of these cadets.

The second period of training is to be of three years' duration, and is to be passed at sea in the higher rank of midshipman; and Lord Selborne is careful in his memorandum to emphasise his intention "that special attention will then be paid to their instruction in mechanics and the other applied sciences, and to marine engineering." This is a very satisfactory pronouncement, and the Admiralty may rest assured that the more rigidly this dictum is adhered to, the more useful in every way will be the naval officer of the future. But whilst engineering and the applied sciences are very properly to occupy a prominent place in the training of the midshipman, he is also to be instructed in seamanship, gunnery and torpedo work, navigation, and pilotage. There will be an annual examination in all these subjects, for which the papers will be sent from the Admiralty as at present. But as if to retain some small relic of the sailing navy which Lord Selborne declares has passed away never to return, the final examination at the end of the three years at sea, and the consequent promotion to sub-lieutenant, are made to depend upon the midshipman having successfully passed the final examination in seamanship before a board of three captains or three commanders. On being promoted acting sub-lieutenant these young officers will return to England, and join the college at Greenwich for a three months' course of mathematics, navigation, and pilotage, to be followed by an examination. They will afterwards proceed to Portsmouth for a six months' course in gunnery, torpedo, and engineering, at the close of which they will be examined, receive their classification 1. 2. 3. in each subject, and on passing out, will be confirmed in the rank of sub-lieutenant. This terminates the second course of training. Up to the present time these young officers have all been trained exactly alike, and they have now arrived at that critical moment in their professional careers—the parting of the ways; for it is now to be decided which branch of the executive arm of the service they are respectively to join—the executive (proper), the engineer, or the marine. And when we come to this stage of the new scheme we are not at all surprised that the Admiralty should have emphasised their preference to give nominations to those candidates whose parents or guardians declare for them that they are ready to enter any one of the three branches, as this declaration must greatly simplify the work of the Admiralty in filling up the various ranks; and it is to be regretted that the Admiralty did not absolutely refuse any option of choice in this matter. It would have wonderfully strengthened their hands, and would have permitted the instructing officers to select the executive, the engineer, or the marine, in strict accordance with the aptitude displayed by the young officers in the course of their training, and their positions at the various examinations. And it must be evident to every thinker that the instructional officers must have far and away the finest opportunities of appraising the bent of mind and the professional aptitude of these young men; their advice—if the final selection be not vested in them—should in any case have very great weight with the Admiralty in allotting the appointments.

As I am considering this new scheme from the engineer's standpoint, it is unnecessary—from this time—to follow any but the career of the "Sub-Lieutenant (E)," who (it may be stated in parenthesis), is now from 19 to 20 years of age, and is now to enter upon the technical and theoretic study of his life's profession. Somewhat late in life, it may seem to some of us, who made acquaintance with the factory and the bench about our middle teens. We can, however, easily afford to give this part of Lord Selborne's scheme a fair and impartial trial; the more so, since the memorandum shows that the duration of the course about to be entered upon, and the programme of the instruction to be given, are still matters "for careful consideration." Considering the complexity of refinement to which modern marine engineering has attained, and the abstruse problems, both phyical and mechanical, which the student of engineering has now to master, it cannot be doubted that at least four years will be required to complete the engineer's education. Lord Selborne tentatively limits it to two years, but it is unlikely that any practical engineer would agree with his lordship on this question. It is undoubtedly the case, that among naval officers of the executive class the idea is prevalent that naval engineering consists merely in knowing which handle to pull or push, in taking care that bearings do not get hot, in ordering the man in charge of the boilers to keep the steam-pressure steady and to take care that he has plenty of water in his boilers, to keep his bilges pumped out, to see that a correct tally is kept of the coal expended per hour, that the proper entries are made in the engine-room register, and that all orders from the deck are promptly and correctly obeyed. These, in the minds of the majority of executive officers, comprise the whole duty of the naval engineer. In fact, as the writer of a recent letter to the *Times* observed (the writer was once an executive officer): "What the service requires is good engine-drivers, not highly educated scientific engineers." Another executive naval officer interviewed on the subject of the new scheme, and described by the interviewer as "one of the most mechanically-minded officers" of his acquaintance, is thus reported:

> "I disapprove altogether of the coming amalgamation of the executives and engineers. The executive officers should supersede the engineer outside the engine room, and for the purpose receive practical mechanical education. In the engine room we require engine drivers such as you see in charge of engines at Barrow, Elswick. The artificer-engineer class are splendid men, and I always send for them when I want a job done.* The proper place for the highly educated engineer officer from the college is in the designing office or at the dockyards."

Admiral Field in a letter to the *Times* with reference to the new scheme, makes use of very similar remarks, in the fifth paragraph of his letter, where he says:—

> " * * The public mind has been much misled, during the controversy of recent years, into overestimating the important duties and responsibilities of engineer officers who are stationed to control and regulate the engines and boilers in a modern ship of war, whereas the designers and manufacturers of these colossal engines and boilers are the persons, in my opinion, entitled to the first place of honour in the public mind, and yet we scarcely ever hear their names mentioned. Pray let us act logically, and if the officers who *drive* the engines are to have executive naval titles, by all means give the same privilege to the designers of both ships and engines."

These quotations from the writings and conversation of executive naval officers (whose opinions have been considered by the leading journal in the empire, and by the *Manchester Guardian*, to be of sufficient weight to justify the editors in reproducing them in the columns of their respective journals), clearly show that there is great difficulty on the part of the executive officers adequately to gauge and estimate the technical and scientific attainments demanded of the naval engineer by the continual progress of the science of engineering, and the ever-increasing complexity of ship construction and naval engines and boilers. Is it attributable to that "little knowledge" which "is a dangerous thing" that the executive officers, living in an atmosphere redolent of mechanics and science of every kind, and who, whether they will or not, must to a certain extent have absorbed some of its ozone—it is attributable to this fact, that they affect to treat naval engineering with such depreciatory permissiveness? I feel pretty confident myself that some of the more thoroughly educated gunnery and

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*** I am curious enough to wish to know in what ship this occurred, and who was the chief engineer? I do not think there are many chief engineers in the British navy who complacently permit the gunnery or torpedo lieutenant to "send always for one of them (artificer-engineers) when" he "wants a job done."**

torpedo officers of the executive class—men who have studied mechanics in connection with their immediate duties, and who have done so in a sympathetic spirit, realising that they could not "run their show" as it is colloquially expressed in the service, unless they have completely mastered the smallest details of their particular branch—these men, I feel convinced, would be the last to underrate or minimise the value of the naval engineer. But I am also aware that the number of such officers in the navy is very limited when compared with the totals of the executive list. Nor do I think it can be doubted that the new scheme is traceable to the fear—present, but strenuously repressed, and never admitted save among themselves—that the engineer was bound to become the most important officer in the navy of the future; and could anything be more distasteful to the successor of Nelson, than that he should have to play "second fiddle" where Nelson reigned supreme? Let me here quote the words of another naval executive officer who has specialised both in gunnery and torpedo work. Writing to the *Times* this officer advocates the reduction of the number of special branches in the navy—the one he would eliminate being that of the naval engineer, for the following reasons:

> "The knowledge of propelling ships and boats by wind power formed the profession of seamen of old. It was common to all in a greater or less degree. The best seaman was he who handled best the propelling power, working his machinery to best advantage with fewest breakdowns, and maintaining it from self-contained resources for the longest period. No man on board knew better than an able captain of old the details of his propelling power as regards spars, sails and rigging. * * * * His chief engineer—the boatswain—could not tell him anything he did not know as regards that most important part of his duty; * * * Cannot my brother officers see that the seamanship of today is knowledge of that power which propels the ship, serves the guns, compresses the air for his torpedoes, gets his anchor up, and his boats in and out? Whoever has the greatest knowledge of these things must eventually come to the top. It is the profession of the fighting sailor, for no sea battles are fought under sail, * * * * Therefore I contend that, * * * * today, every naval officer must be proficient in the power which propels his ship. * * * * The new scheme must be welcomed because it is a great step towards such a consummation."

The great desire of this officer is to get rid of the engineer! And yet, how illogical he is. The whole extract which I have given of this letter is one long argument in assertion of the predominance of the engineer—the officer of whom he proposes to rid the service.

To sum up then my conclusions as to Lord Selborne's new scheme, in so far as its provision will affect the naval engineer officer *of the future,* I think they may be briefly epitomised thus:—

1. That the scheme is conceived in the true spirit which should underlie all reforms—the desire to introduce something which shall be workable, elastic; something which experience may be able to modify and improve as defects present themselves in the developments of the future.

2. That it makes no pretence of finality, but courageously states those points which are still under consideration, or have yet to be determined.

3. That its success will in a great measure depend on the prevalence of sympathetic and liberal minds in those who have to carry out its provisions.

4. That more than all, its success will depend on the thoroughness and depth of the instruction in engineering imparted in each stage of the curriculum; and the provision in the various factories and workshops in which practical manual engineering is to be taught, of the most up-to-date machines, tools, and instructors, that can be procured.

In the foregoing pages of this article, I have considered Lord Selborne's new scheme from the standpoint of its probable success in the creation and training of the naval engineer officer of the future; I now come to consider it in its relation to the existing naval engineer officer. Lord Selborne's opening sentence of the paragraph which deals with "The Present Engineer Officer" must have been read by every engineer officer with satisfaction and hope, and yet as he read, there must have been present in his mind—though possibly not articulately expressed—the wonder why, if his services have been so greatly appreciated by the Admiralty, his place in the navy is henceforth to be occupied by another? But let me quote the paragraph in question. Lord Selborne says:

> "The Board are confident that the naval engineer officer of the future will maintain to the full the high traditions of the present engineer branch, but they feel that this scheme would not be complete if it did not include changes designed to harmonise as far as possible the position of the present officers of the engineer branch with the spirit of the future organisation."

After passing such a high eulogium on the present engineer officers, one naturally expects that it will be followed by the declaration of a generous and liberal policy in respect of the claims which for so many years have been urged on the Admiralty by the engineer officers and by their friends and supporters. It is not very much that they have asked for, and the principal item in their request has been one calculated rather to enhance the value of their services towards the navy itself than to be of any personal advantage to themselves, *viz.*, that they might be accorded executive rank with its accompanying accessories of title, insignia, and authority, so that in the execution of their multifarious and responsible duties they might have their hands strengthened and upheld by the prestige which executive rank has been wont to confer upon its possessors. The present engineer officers have never—as far as my information goes with regard to their wants and wishes—asked for more than the power and authority to reward and punish the men of their own department; and that, to that extent, they should be granted executive rank with its accompanying titles and insignia. The other changes asked for by the present engineer officers it is unnecessary for me here to touch upon, as they do not in any way bear upon the scheme we are considering. The Memorandum proceeds as follows:

> "Accordingly, the following changes will be made in the designations of rank:—
>
> "Engineer students will become engineer cadets, and the college at Keyham will be known as the Royal Naval Engineering College.
>
> "Assistant engineers for temporary service, and assistant engineers, will become engineer sub-lieutenants.
>
> "Engineers, chief engineers, and staff engineers will become engineer lieutenants.
>
> "Fleet engineers will become engineer commanders.
>
> "Inspectors of machinery will become engineer captains.
>
> "Chief inspectors of machinery will become engineer rear-admirals.
>
> "The engineer-in-chief will become engineer rear-admiral, and the Board reserve power to promote the officer holding that high post to the rank of engineer vice-admiral if thought advisable.
>
> "The average period of reaching each rank will be assimilated as far as possible to that of the executive branch, so as to correct the present disparity of age, which often obtains between officers of the two branches of relatively equal rank; the pay of existing engineer officers will be raised, but no changes will be made in their uniform or in the regulations which define their duties, or in the provisions of the Naval Discipline Act.
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> "The Board have given their careful and earnest consideration to all the suggestions which have been made from a variety of quarters for further changes affecting the present engineer officers. The decision at which they have arrived is, they are convinced, that most conducive to the interests of the service as a whole."

Lord Selborne and his colleagues must have worn a pensive smile, like Mark Twain's "Mrs. M. R.," when they penned the above sentences. I sometimes wonder whether the Admiralty have grown to believe—because the present engineer officers have waited so long and so patiently for the "turning in the lane"—that these officers can be always relied upon to mistake the shadow for the substance, and to accept as an unmerited concession any "unconsidered trifle" they may contemptuously fling to them? Unless their lordships do entertain some such opinion as this of the engineer officers of the navy, it is difficult to conceive by what line of reasoning they can have persuaded themselves that such a miserable burlesque of executive rank could be acceptable to the present engineer officers. And, as if it were not sufficiently degrading to these officers to be invested with the mockery of the thing ostensibly granted, the Admiralty have gone a step further, and have provided these officers with titles which will invidiously distinguish them forever from the engineer officers of the future. See table of titles below:

| Future Engineer Officers. | Present Engineer Officers. |
|---|---|
| Sub-Lieutenant (E) | Engineer Sub-Lieutenant. |
| Lieutenant (E) | Engineer Lieutenant. |
| Commander (E) | Engineer Commander. |
| Captain (E) | Engineer Captain. |
| Rear-Admiral (E) | Engineer Rear-Admiral. |

It is painful for any honest straightforward man, who has been accustomed all his life "to call a spade a spade," to have to deal with such casuistry and jesuitical reasoning as are here shown to have commended themselves to the minds of the officials who drew up this scheme. Truly may it be said "they asked for bread and were given a stone." The only consolation to be found in this precious scheme is, that its provisions are subject to modification and improvement as time goes on. Lord Selborne will be well advised if between now and the date on which it comes into force, he shall have removed these blots and disfigurements from an otherwise well-conceived plan of reform.

I cannot close this paper, without giving the readers of THE ENGINEERING MAGAZINE some indication of what—in my opinion—would have been a much more satisfactory way of dealing with the engineering difficulty in the British navy. The drastic reform—it might not inaptly be termed a naval revolution—which Lord Selborne has had the courage to initiate, was not necessary from an unbiassed naval point of view. The navy was geting on with its work in a satisfactory manner as far as the executive branch of the service was concerned, except perhaps that a few ambitious officers were desirous to usurp the functions of the engineer officers, especially in regard to mechanical appliances connected with guns and torpedoes. It was quite unnecessary that the gunnery and torpedo lieutenants should be converted into engineers, or that the engineer should be converted into a seaman.

But what was necessary, and what should have been done, was to strengthen the engineer's position by investing him with executive rank and control in his own department, to increase his staff to a degree commensurate with the vast cares and responsibilities and duties which properly belong to the engineering staff of a ship of war, and to invest him with the supreme control of everything mechanical within the ship, subject only to the direction of the officer in command. I will conclude with some extracts from the letter of an executive officer which appears in the *Times* of today (17th Jan., 1903) over the signature, "A late Captain of a Battleship."

> "Having lately given up the command of a battleship, I think I know to a great extent the opinion of the executive officers on the question of education, and also the proposals of many of the present engineer officers for improving their position on board ship. With these proposals I have always sympathised. * * * * The crux of the whole question turns upon the engineers.* * * * Under the new scheme is the navy to get better engineers than we have now? My opinion of the present engineer officers is that they are most zealous and efficient officers, and that it will be very difficult to improve on them. * * * * If it is only hoped to obtain as good engineers as you have at present, it seems a great and unjustifiable risk to turn the service upside down for the purpose of doing so. * * * The demands of the present engineer officers to better their position are very reasonable. I believe that the enormous majority of them are proud of being engineers, and justly so, and do not wish to be called lieutenants, captains, or even admirals; but they think that their rank should correspond with officers of the executive branch of the same age, and that their pay should be increased, and, above all, that they should have authority to punish men under their orders for technical offenses—in fact, that practically they should be made into a corps. The right of punishing may seem strange to be considered so important, but no body of men can be satisfactorily governed unless the officer in charge of them has the right to decide questions of neglect of duty and to punish those in fault.
>
> "I may say that many executive officers entirely sympathise with the present engineer officers in their claims, which are certainly just, and think that if they were conceded, the result would be more satisfactory than anything that can be possibly obtained under the new scheme."

The officer whose words I have quoted above has so accurately gauged the situation that it is unnecessary for me to add another word. I will say only that if men of his stamp occupied all the seats on the Board of Admiralty, the engineering difficulty which has agitated the British navy for the last forty or fifty years would be solved without requiring a "Revolution" such as Lord Selborne's scheme involves.

# EDITORIAL COMMENT

THE idea of a general building for the housing of the libraries and offices of the various engineering associations, together with the provision of an adequate meeting hall to be used for conventions and other gatherings, is gaining in favor in different quarters. All that is really necessary for the active development of the plan is a full realization of the fact that it does not involve the slightest change in the management and relations of the several societies, and that no objection on any such score can be considered as relevant. If, for instance, a realty-holding association should be formed to construct and maintain a building arranged upon the general lines of a great office building, but including in its plan a large auditorium and modern library book stacks, it would make no difference in the relations of the various societies for them to rent office and library quarters and to hire the hall for their several meetings. That such a realty organization should be composed of the governing bodies of the societies might or might not be practicable, but in no case would it affect the internal management of the associations, such as dues, requirements for membership, research work, and the like. At the same time all would have the great advantages of the use of an unparalleled professional library, covering all branches of engineering work; all would have at their services an auditorium for meetings which a properly arranged schedule would keep in constant use; and best of all, the various members would be brought into a contact and association which could not fail to be of great benefit, both personal and professional.

In such a building the expenses would be reduced to a minimum, as compared with the facilities provided, and indeed it is a question whether such a building ought not to be large enough to provide many offices for rent to members for their business purposes. If the latter feature were included there is little doubt that the establishment might be made self-supporting, since the advantages of offices under the same roof as such a reference library as that composed of the collections of the various bodies would in itself be enough to insure a complete rental of all the rooms.

That one of the national societies has already a handsome house of its own is hardly a sufficient objection to the plans. Engineers are notably men of change, and there is no great railway company, for example, which would hesitate to tear down and remodel or remove a newly-built terminal if sufficient advantage could be shown, and no engineer but would advise such action if consulted about it. The position of the engineer in matters relating to business and commerce is growing more and more influential daily, and if all branches of the profession will act together they will find the control and supremacy of the work of the world and the fruits of its development in their hands.

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THE recent action of the British Admiralty in suddenly abandoning their long and stubbornly held position, and placing the engineers of the navy henceforth on full equality with the "executive" or line officers, is doubly interesting to American engineers. First, it is an unreserved official acknowledgment of the engineers' long-ignored claim to a position corresponding to his real importance on board ship—an acknowledgment from the navy which is at once the most powerful in the world and the most under the conservative influence of old-time tradition. Second, it is a thorough-going adoption, and even extension, of the ideas embodied in the United States Personnel Law, for which this Magazine fought earnestly and consistently. If American initiative has influenced the administration at Whitehall to this excellent reform, let us hope that the vigor with which Britain has now acted will strengthen the mind of the Administration at Washington to make a good law wholly effective in the American navy.

For it must have seemed at times, even to those usually well posted on the progress of events in the United States navy, as if Admiral Melville were almost alone in his fight for the enforcement of the amalgamation feature of the Personnel Law, which President Roosevelt (while assistant secretary of the navy) made so prominent in his report as chairman of the Personnel Board, by his much quoted remark, "On a modern war vessel every officer has to be an engineer." This dictum appealed to us as the forceful enunciation of a great truth, and we have been glad to lend our voice to the advancement of this great scheme of naval progress. Admiral Melville has never varied in asserting his faith in the efficacy of this plan, *if honestly carried out*. But that has been the whole trouble. For a long time it almost seemed that it was the deliberate intention of the naval authorities to make this basic feature of the Personnel Law fail by doing absolutely nothing to enforce it. The younger engineers were transferred to deck duty, but there was no corresponding transfer of young deck officers to the engine room. We are glad to know that an effort, albeit a feeble one, is at last being made to train all the young officers as engineers.

It had seemed that the only man of prominence in the navy who cared for engineering efficiency was Admiral Melville, but the report of Admiral Bradford, chief of equipment, which has recently appeared in its complete form, shows that another high official, and one trained in the old school of deck officers, is also sincerely concerned about the same subject. His remarks are so strong an argument for the accuracy of the President's position that we have given an extract in our Reviews elsewhere in this issue.

Admiral Bradford starts out with the statement that the modern war-ship is a most complicated machine, filled with complicated machinery, and needing men skilled in the knowledge of such machinery to handle it efficiently. He develops this theme admirably, and closes by saying, "Engineering knowledge is constantly required of officers when at sea." We are glad to note that this is not a belated opinion of the Admiral, but that, as given in his report, it is a repetition of a former opinion submitted to the Navy Department. We feel that this frank expression of his views by an officer of Admiral Bradford's standing is a most encouraging sign for the friends of engineering efficiency in the navy, and we hope it will encourage other progressive men of high rank to put themselves on record with Admirals Melville and Bradford, and so hasten the completion of the transition period and bring its fruition in the shape of the modern naval officer—the fighting engineer.

# REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

## THE TRAINING OF NAVAL OFFICERS.

### NEW REGULATIONS FOR THE ENTRY, TRAINING, AND EMPLOYMENT OF OFFICERS AND MEN OF THE ROYAL NAVY.

*Memorandum of the First Lord of the Admiralty.*

AT last the Admiralty has been aroused by the incessant efforts of civilians and by the engineering press to a realisation of the danger in the existing state of affairs with regard to the engineer branch of the naval service, and in a memorandum, signed by the First Lord, and recently made public, the beginning of a new order of things is announced. We say the beginning, because the plan set forth in the memorandum relates, so far as the present is concerned, with the education and training of the men by whom the vessels of the navy are hereafter to be supplied. That this is the right place to begin, all will admit, and if the plan is but carried out with a degree of thoroughness permissible under its provisions it should result in giving the navy an engineering strength and efficiency the lack of which is now its most serious defect.

That such a change was impending, some clearly foresaw. Writing in this Magazine in September, 1902, in comment upon the gloomy forebodings of Mr. Johnson, Mr. McFarland said, referring to the transfer of certain duties from the engineers to executive officers: "As a matter of fact, in my judgment, this is simply the beginning of a movement which is bound to lead to the same results as have been reached in the American navy."

Mr. McFarland called attention to the fact that when Mr. Welles was Secretary of the United States Navy, as far back as 1864 and 1865, he recognised the fact that the thoroughly competent naval officer should be an engineer as well as a sailor. More recently Rear Admiral Bradford, Chief of the Bureau of Equipment and Repair, in the United States navy, said:

"A modern ship of war is one of the most complicated machines in existence. It is filled with machinery of various sorts from one end to the other. The finished ship, ready for service, is of great cost and enormous value to the government. It is worth nothing unless efficiently handled and kept in readiness for service. These duties devolve upon seagoing officers; they must operate, repair and tenderly care for the immense number of living parts of their ships. In intricacy they compare with the arteries, veins, sinews, and other parts of the human body. Is it expected that officers and men who, when placed on board of a ship, make their first acquaintance with this vast number of machines and moving parts, can understand them? Is it expected they will know how to manipulate them if without previous experience and ignorant of their design and construction? It requires no professional knowledge to decide such a question. A great proportion of the repairs now required to the interior parts of cruising ships are caused by a want of familiarity on the part of those who have charge of them. The only possible way that these ships can be kept efficient is to have the officers and men who go in them, and who are responsible for their efficiency, obtain previous knowledge of their internal fittings by supervising their construction. The best engineers found on board of the modern ocean greyhounds are those from the shops of Glasgow and other great shipbuilding plants. The best locomotive driver is the one who has built his engine and knows every screw, every rivet, and every part in it. There is no doubt that all interior moving mechanism actuated by steam, compressed air, hydraulics, or electricity should be constructed and installed under the supervision of seagoing officers.

"I believe that all seagoing officers should spend a considerable amount of time on shore acquiring a knowledge of the integral parts of the huge and costly machines placed in their hands when at sea and which they must fight and maintain ready to fight."

The result of all the agitation in the United States was the enactment of the so-called "personnel" law, which provided for the amalgamation of the engineer and line, or executive, officers, with the idea of making every officer an engineer, giving positive rank to all alike. The operation of this law has unfortunately been hampered by the absence of an enforcement clause requiring regular alternation of service on deck and in the engine room, and Admiral Melville has repeatedly called attention to the necessity of some order or enactment covering this point, but in its essential features the personnel law of the United States navy is a frank acceptance of the fact that every officer on a modern war vessel has to be an engineer.

In the introduction to the present memorandum, Lord Selborne now takes practically the same position, accepting the facts which have been so forcibly laid before him by Mr. D. B. Morison and the other engineers who appeared before him in deputation about a year ago. After referring to the changes which have resulted from the adoption of steam power, and the development of the modern ironclad, he proceeds:

"In the old days it sufficed if a naval officer were a seaman; now he must be a seaman, a gunner, a soldier, an engineer, and a man of science as well. It is not only that machinery driven by electric, hydraulic, or steam power is every year becoming more complicated in character and multiplying in form, and that therefore a more extensive education in applied science is necessary for specialised officers, but in various ways the need for a more general scientific training has become apparent."

The necessity for unity in action of all departments of the service must be admitted, but under the present system such action is practically impossible.

"The executive, the engineer, and the marine officers are all necessary for the efficiency of the fleet; they all have to serve side by side throughout their career; their unity of sentiment is essential to the welfare of the navy; yet they all enter the service under different regulations, and they have nothing in common in their early training. The result is that the executive officer, unless he is a gunnery or torpedo specialist, has been taught but a limited amount of engineering, although the ship on which he serves is one huge box of engines; that the engineer officer has never had any training in executive duties; that from lack of early sea training the marine officer is compelled, sorely against his will, to remain comparatively idle on board ship when every one else is full of work; and that the spirit of unity has not yet been carried to its full development."

Having this unity in view the new scheme provides for a standard and uniform preliminary training for all three branches. Thus it has been decided that henceforth:

"All officers for the executive and engineer branches of the navy and for the Royal marines shall enter the service as naval cadets under exactly the same conditions, between the ages of 12 and 13; that these cadets shall all be trained on exactly the same system until they shall have passed for the rank of sub-lieutenant, between the ages of 19 and 20; that about the age of 20, these sub-lieutenants shall be distributed between the three branches of the service which are essential to the fighting efficiency of the fleet—the Executive, the Engineer, and the Marine."

The result aimed at is, to a certain point community of knowledge, and lifelong community of sentiment. The only machinery which can produce this result is early companionship and community of instruction. These opportunities will be secured by a policy of one system of supply, one system of entry, and one system of training.

The details of the system of education

cannot be given here, but, in brief, it includes four years at the Royal Naval College, and three years at sea as midshipmen, all studying alike the theory and practice of seamanship, navigation, gunnery, torpedo work, and engineering. The three years' cruise will be followed by three months at Greenwich in mathematics, navigation, and pilotage, and six months at Portsmouth in gunnery, torpedo work, and engineering; after which the candidates are to be examined and passed on to the rank of sub-lieutenant.

Here comes in the critical point in the system. The sub-lieutenants now are to be differentiated to fit them for the several departments in which their work will thenceforward be applied. The three branches of the executive, the engineer, and the marine will be filled, primarily by the choice of the candidates themselves, but preferably by the selection of the Admiralty. It is assumed that the greater part of the men will leave the distribution to the Admiralty, but so long as human nature continues to be as it is, we may be reasonably sure that the more attractive executive branch will be sought by most. This has been foreseen in the provision for greater proportional pay in the engineer branch, to make up for the greater attraction of the executive branch, but it is more than possible that the question of choice will have to be eliminated altogether, and the men placed by the government where they are most needed.

The vital points of rank and executive authority in their domain have not been overlooked for the engineers, and the necessity for granting these has been realised and accepted. Thus the whole scheme appears to be reasonably complete, needing only the lessons of experience in carrying it out to enable the defects to be remedied. That the plan is the result of numerous compromises is evident from a mere examination of the wording of the memorandum, but when we consider that it was prepared by a board on which no engineer officer had a seat, we cannot but express surprise that it grants as much as it does.

As the scheme goes into effect in July, 1903, seven years must elapse before the first lot of sub-lieutenants will present themselves, under the new system, for appointment in the several branches of the service, and we may reasonably suppose that at least ten years must elapse before any very appreciable effect can be expected in the personnel of the navy. It is devoutly to be hoped that no great naval war may occur before that time, and compel a disastrous exhibition of the true state of affairs existing at the present time.

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# THE FRICTION OF HIGH-SPEED JOURNALS.

### DATA AND RESULTS OF RECENT INVESTIGATIONS IN GERMANY COMPARED WITH EARLIER EXPERIMENTS.

*O. Lasche—Verein Deutscher Ingenieure.*

FOR a long time the early experiments of General Morin concerning the laws of friction were accepted as conclusive by engineers in all parts of the world, but there is no doubt that this was partly due to the absence of reliable experiments by any other authority. The general results of experience in machine construction, however, led numerous observers to perceive that modern methods of lubrication, together with the high speeds in practical use, caused material modifications in the older laws to be necessary. The experiments of Woodbury, Thurston, and Tower proved conclusively that in many instances the coefficients deduced by Morin were too high, and also that the speed of the rubbing surfaces exerted a distinct effect upon the amount of friction. The question of temperature appeared as an important element in the problem, so that the whole subject has gradually assumed a more complex form than was formerly assumed to be the case.

In the course of the experiments with the high-speed electric locomotives constructed by the Allgemeine Elektricitäts-Gesellschaft upon the Berlin-Zossen military railway it became evident that further experiments upon the frictional resistance of extremely high speed journals were desirable. An extensive series of tests was therefore made by the company, and the data and results as well as an full account of the methods employed, are contained in a series of papers by Herr O. Lasche in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure,* from which we make some abstracts.

Formerly journals running at high rotative speeds were subjected to light pressures and could be made of small diameter, giving moderate lineal speeds. When heavy loads were to be sustained the speeds were usually slow and the necessary bearing surface was obtained by lengthening the journal. At the present time, however, engineers are obliged to consider bearings in which the speeds are from 1,000 to 3,000 revolutions per minute, while the shafts carry armatures or fly wheels of many tons in weight. These conditions demand journals of large diameter, in order to secure the necessary strength and stiffness, thus introducing the necessity for high circumferential speeds, while it is also desirable that the journals be of moderate length, in order that perfect bearings should be assured, this involving high unit pressures. Under such circumstances it is evident that the results of earlier experiments, conducted under altogether different conditions, cannot be accepted as safe guides in design.

Herr Lasche discusses the experiments of Woodbury, Thurston, and Tower, plotting them in an ingenious system of isometric co-ordinates permitting the exhibition of three dimensions in a convenient graphical manner, and showing that even with the moderate limits within which they were conducted the coefficient of friction varied with variations in speed and temperature, contrary to the experiments of Morin. For modern conditions, however, in which the lineal speeds of the journals are as high as 10 to 30 metres per second in connection with pressures as great as 10 to 15 kilogrammes per square centimetre, these earlier experiments furnish but indications of the necessity for further investigation.

For a detailed description of the apparatus used in the present experiments reference must be had to Herr Lasche's original papers. In general it consisted of a short shaft, supported in its own bearings at the end and surrounded by the experimental bearing between. The experimental bearing was arranged so that a lifting force could be exerted upon it, this bringing the load upon the lower half of the journal box. The lubrication was effected by the ring system and also could be maintained by a continuous flow, while the speed, temperature, and power were capable of independent variation and of continuous and accurate measurement. Electric driving was employed, so that the power was under close control and observation. With this apparatus tests were made with circumferential speeds as high as 25 metres per second, and under pressures reaching 15 kilogrammes per square centimetre, while temperatures above 100° C. were observed, the higher temperatures being artificially produced by electric resistance coils.

The general results of the experiments may be abstracted as follows:

When the speed and the temperature remained constant, the former being 10 metres per second and the latter 50° C., the coefficient of friction was practically constant for all the materials experimented upon, being equal to 0.04, the work of friction naturally increasing with the dimensions of the journal. If the speed and the temperature remained constant it was found that at first the coefficient of friction increased with the speed, until a velocity of between 10 and 15 metres per second was attained, after which further increase in speed produced a very slight effect, the coefficient remaining practically constant.

With regard to the influence of temperature, the experiments of Tower were confirmed in that the coefficient of friction diminished with the rise in temperature, up to about 100° C. When, however, the temperature passed 125° C. the oil ceased to act as a lubricant, and the work of friction became excessive, so that it is advisable to keep the temperature below about 100° C. in practice. This may generally be accomplished by making the bearings of sufficient mass to permit the rapid conduction of the heat away from the bearing. It is also well in high speed bearings to provide an oil reservoir of sufficient capacity to allow time for cooling, in which case the temperature may be kept down by continuous circulation of the lubricant.

So far as materials are concerned, the results of tests with journals of open hearth steel, tool steel, and nickel steel, running in bearings of gun metal and white metal. showed that no appreciable change was produced in the coefficient of friction. The choice of material may therefore be left to other considerations than those of friction. White metal is to be preferred to bronze or gun metal, for bearings under heavy pressure because it gives gradual warning of heating and wear, instead of seizing the journal, as may occur with gun metal bushings.

The character of the lubricant also is of comparatively small consequence, provided a good quality be used. Sperm oil gave slightly better results than rape seed or imperial oil, but it was evident that the distribution of the lubricant is more important than moderate variations in quality. The oil passages cut in the bushings should be so formed that the lubricant is drawn in the direction of rotation, and sharp edges should be avoided as apt to scrape the oil from the surface which it is intended to lubricate. Herr Lasche, however, emphasises the value of the oil as a cooling medium, maintaining that an oil reservoir of ample size accompanied by an active circulation of the lubricant is the most effective means of maintaining a safe working temperature which can be employed.

In view of the increasing employment of high rotative speeds in large and heavy machinery these later researches upon the conditions surrounding frictional resistance cannot fail to be of great value to the designing and operative engineer.

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# THE ELECTRIC DRIVING OF MACHINE TOOLS.

## A CONSIDERATION OF THE REQUIREMENTS OF MACHINE-TOOL OPERATION WITH ESPECIAL REFERENCE TO ELECTRIC DRIVING.

*Charles Day—New York Electrical Society.*

IT is becoming more and more fully appreciated that the maximum efficiency in machine shop operation can be attained only by taking into account all the varied operations in connection with their dependence upon each other, and that any attempt to treat a single question by itself must result in an imperfect solution of the problems with which it is connected. There has undoubtedly been much misunderstanding in regard to the advantages and defects of electric driving of machine tools, because it has thus been considered as a thing apart from the operation of the tools themselves, when the question is above all others dependent upon the whole subject of shop operation. The motive power is but one element in the general scheme of which every part should be given its due proportion of consideration.

In a paper recently presented before the New York Electrical Society by Mr. Charles Day, the relation of the requirements of the machine tool operations to the motive power are discussed in connection with electric driving, and some abstracts of his treatment of the questions are here given.

After calling attention to the advantages of the graphical method of analysing the details of the cost of manufactures, the importance of the development of the full capacity of the tool equipment is noted. This development should begin in the pattern shop and the forge department, where the work should be prepared for the tools with full consideration not only of the finished product but of all the operations which it must undergo in the machine shop. Given properly prepared material, in shape for convenient handling and machining, the method of conducting the machine work must be considered as the removal of the necessary amount of material from the proper places, producing a finish of a definite amount and character in the minimum amount of time.

The machining involves three elements, the tool which actually does the cutting, the machine by which the work and the determinate movements are performed, and the motive power by which the machine is impelled. Since the capacity of the machine and the amount of power by which it is driven are entirely within the control of the designer, it is evident that the speed limit of the operation is to be found in the material of the tool. In this respect too much weight cannot be placed upon the importance which the modern high-speed tool steels bear to the efficiency of the machining process. Ever since the discovery by Messrs. Taylor and White, that the cutting capacity of air-hardened tool steel could be vastly increased by proper heat treatment, the use of such steels has been increasing, and the influence which the adoption of improved materials for cutting tools is having upon machine-tool design is a most interesting element in the question of driving. The possesion of these steels has rendered previous data concerning the cutting speeds for various materials obsolete, and fresh experiments have become necessary to enable the maximum cutting capacity of existing tools to be determined and to permit designs for new machine tools to be given sufficient strength and powering.

The use of electric driving upon existing machine tools has rendered it possible to make such determinations with ease and accuracy, and such experiments have shown that cuts of 3/16 inch in depth with a feed of .0606. could be maintained in cast iron at speeds of 100 to 125 feet per minute. At the present time it appears that the most inefficient part of many shops is the machine equipment, and until this fact is fully realized by the user the maximum output cannot be reached. With existing tools the feeds provided are altogether too slow, while the amount of power supplied and the rigidity of the framing are both out of all proportion to the cutting capacity of the tools which may safely be used.

Having considered the cutting tool and the character of the machine in which it is to be used, the subject of the motive power may be considered intelligently.

"A machine having been designed for a given duty, its maximum and minimum speeds are limited by the character of the work it will do; the number of speeds is determined by the character of the metal machined, and the uniformity of the tool steel and the power required is fixed by the most severe conditions it must meet.

"For the average machine tool present conditions do not demand a closer speed regulation than 10 per cent., as no good means has yet been reached for determining the character of the metal, and in the average shop little is understood about the relations existing between feed, speed and depth of cut for various materials.

"There are two sides to the question, viz.: the refinement of speed required by the various elements with which we are dealing and the possibility of using this refinement to its full efficiency in actual practice. The first set of requirements may demand a speed regulation of 10 per cent., while the second would indicate that it is extremely difficult to use it to advantage in actual practice with present facilities."

It is evident, therefore, that if the machining is to be done to the best advantage the speed of the tool must be under direct and very convenient control, so that any change required for the conduct of the work to the highest advantage shall be made by the operator with such readiness that he may not fail to avail himself of it. Thus the cutting speed for steel depends upon its tensile strength and elongation, while for cast iron several variable elements enter, the hardness being affected not only by chemical composition but also by the method of cooling and the size and form of the casting.

With the existing belt driven tools the methods of changing speeds by the use of cone pulleys and back gearing are altogether unequal to the demands for numerous and immediate speed variations, and unless electric driving can do better it will not prove itself satisfactory for the improved order of things. When the most efficient speeds for all kinds of work have been arranged and tabulated, and the workman has been provided with appliances enabling him to determine the speeds which he is obtaining on the cutting surface, it is absolutely essential that he shall be able to control the speed of the machine from any point where he may be obliged to stand, without having his attention diverted from the work, and without being compelled to go through any such performances as shifting belts or changing gears.

This requirement of ready and convenient speed control indicates that the induction motor is unsuited for the best operation of machine tools under existing conditions. When used with cone pulleys or variable speed countershafts it is no better than the same devices operated from a line shaft, so that there is nothing to be gained by its use. Probably the best results will be obtained by the use of variable-speed motors with multiple voltages, and such a plan with provision for intermediate speeds obtained by inserting resistance in the field, appears to offer promise. In any desirable system standard motors should be utilized, the controller being operated by a single handle, with the entire range of speeds capable of being passed over while the work continues.

It is evident that electric driving, to be a success, must do so much more than merely replace line shafting and belt driving. It must form a part of the new order of machine-shop operation, in which every tool is being operated at its maximum capacity for the greatest possible part of the time, and in which each piece of work is required to be executed in a predetermined limit of time, fixed by the nature of the material, the capacity of the cutting tool, and the previous experience of the superintendent.

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# MODERN POWER DEVELOPMENT AND TRANSMISSION.

### IMPROVEMENTS IN SUBDIVISION AND APPLICATION OF POWER THE SOURCE OF THE EFFICIENCY OF THE WHOLE PLANT.

*Prof. J. J. Flather—American Association for the Advancement of Science.*

A LARGE part of the efforts of engineers has been devoted to the attainment of economy in power generation, and each fraction of a pound which has been cut off of the consumption per indicated horse power has been recorded as another step in steam economy. While this has doubtless contributed in no small degree to the improvement of the steam engine, and made for mechanical progress generally, engineers are beginning to perceive that it is quite possible to make a plant too efficient in one part at the expense of increased losses in other portions, and that it is the efficiency of the whole which demands consideration.

The vice-presidential address of Professor J. J. Flather, before the section of engineering and mechanical science of the American Association for the Advancement of Science discusses the modern tendencies in the development and transmission of power in this light, and some very interesting examples are given to show how every detail of a plant is involved in the final efficiency.

In the first place the various elements should be considered in proportion to their relative importance. In nearly all establishments the labor cost is much greater than the cost of both power generation and transmission, so that any expedient by which the labor cost may be appreciably reduced is justified, even though the cost of the power be increased thereby. The expenditure of power is therefore a consideration secondary to the advantages and economical output obtained by its use. These advantages include not only immediate convenience to the operator, but also the ease of arrangement of tools, facility in extension of plant, saving of floor space, and everything which conduces to better utilization of the work of the employees.

Naturally the element in power application which affects most nearly the efficiency of the labor is that of transmission. It is freely admitted that transmission by shafting and belting, even when the line is well planned and accurately aligned, absorbs a large proportion of the power generated by the engine, ranging from 30 to 50 per cent., according to circumstances, and even attaining to 75 per cent. of the total power in instances where the buildings are scattered and distances are excessive. As an example of the extent to which transmission losses may offset the benefits of an economical power plant Professor Flather cites the experience of the Baldwin Locomotive Works, in which it was found to conduce to a higher general efficiency to replace an economical central Corliss engine by a number of less efficient smaller engines in various parts of the works, in order to diminish transmission losses.

Naturally the knowledge of the magnitude of transmission losses with the use of shafting and belting has led to a consideration of electric driving, and in many cases a marked economy has been shown by the substitution of electricity for the older systems of transmission. The efficiency of electrical transmission of power, however, is not always higher than mechanical metheds, as Professor Flather clearly shows. It is common to assume for electric motors in such computations their maximum efficiency, while in actual service the average burden will be not more than two-thirds full load, so that the motor efficiency should not be taken at more than about 75 per cent. Combining this with the generator and transmission losses gives a total efficiency of about 60 per cent. of the power of the engine delivered at the tool.

In considering the advantages of electric transmission, therefore, it is wise to assume that the actual efficiency of the electric portion is not appreciably greater than that of shafting, unless the location of buildings renders the case a special one. The principal gain due to electricity, therefore, must be found in other considerations than those of mere efficiency of transmission, and those other considerations are not difficult to perceive. Thus the ability to arange the position of the machines on the floor may result in a gain of floor space of much greater value than the whole cost of the power used, or it may enable the operators to work to better advantage, and thus increase the output proportionately.

The ability to take the power tool to the work is in many cases a cause of saving in time amounting to far more in money value than the amount of power involved, besides the possibility which it affords for replacing expensive hand labor by power machines and tools. These are the strong points of electric transmission, and it is to such considerations that the works manager must turn, and not to the secondary one of mere power economy.

The method of distribution also comes up for consideration. At the present time much is heard about the great advantages of an independent motor to each machine, but Professor Flather shows that the question should be decided according to the conditions of each case. When individual motors are employed, each motor must be capable of overcoming the maximum resistance of the tool to which it is attached. This means that in many instances its average load will be much less than its most efficient capacity. Thus a planer opposes far more resistance at the moment of the reversal of the platen than at any other time, and the motor must be able to overcome this. For such purposes the motor should be capable of sustaining a large overload for a few moments, and unless the designer understands the nature of the tool to be driven the results may be anything but satisfactory. When there are wide variations in the amount of power required the average efficiency of the motor will be very low, and in such cases it may be advisable to resort to group driving, the electric motor operating a short line of shafting from which several machines are driven. The motor may then be proportioned much more nearly to the average load of all the machines which it drives, since the maximum resistance will never be offered by all the machines simultaneously.

In considering the question of prime movers Professor Flather called attention to the great advantages of the internal-combustion motor when used in connection with producer gas or with the waste gases from metallurgical furnaces. The high thermal efficiency of the gas engine and the lower cost of the fuel used combine to render this the most promising direction for efforts to secure greater economy in the generation of power. The reciprocating steam engine, while approaching its limits, has not yet reached its highest degree of perfection, and higher economy may be expected by the use of high-pressure superheated steam in compound jacketed engines. The question, however, is not so much higher efficiency as it is economy of operation. From this point of view the steam turbine offers advantages superior to those shown by its predecessor. The superior steam economy of the turbine under variable loads, and its marked capacity for temporary overloading without impaired efficiency show that under modern conditions it must become a most formidable competitor of the slow-speed reciprocating engine.

Broadly, then, the tendencies of modern engineering in the field of power generation and transmission are in the direction of greater efficiency, not primarily of the generating machinery, but of the machinery of application, and especially of the labor of the operators. These results being accomplished, steam or fuel economy may well be considered, but it should always be remembered that it is the total efficiency of the whole plant which should be attained.

# GEODETIC WORK IN HIGH LATITUDES.

### THE MEASUREMENT OF AN ARC OF THE MERIDIAN IN SPITZBERGEN BY THE RUSSIAN-SWEDISH EXPEDITIONS.

*A. Hansky—Revue Générale des Sciences.*

OUR present knowledge of the figure of the earth is based upon the comparison of various measurements of arcs which have been made upon its surface. These measurements have been made at widely differing periods by means of methods and apparatus of varying degrees of precision, and hence an important element in the whole problem has been the determination of the relative weight to be given to the different data. For this reason it has been thought desirable to repeat some of the earlier measurements, or to make entirely new ones by which they may be replaced or checked. Thus the famous measurements which were made in Peru about 1740 by Bouguer and La Condamine to determine the length of an arc of the meridian near the equator, are being repeated by an expedition under the auspices of the French government, while the work of Maupertuis in Lapland is to be replaced by an arc measured in Spitzbergen, nearly 12 degrees further north, by parties sent out by Sweden and by Russia.

The work of the Russian party in Spitzbergen is described in a most interesting manner in recent issues of the *Revue Générale des Sciences* by M. Hansky, one of the staff of the observatory of Pulkova, who himself was a member of the party and took an active part in the work.

Spitzbergen lying between 76° 31′ and 80° 50′ north latitude, is only about 1,000 kilometres from the north pole, and is practically the furthest land north available for geodetic work, involving the establishment of permanent monuments and stations of definite location. Formerly a great fishing ground, especially for the whale fisheries, the islands are now but rarely visited by fishing vessels, occasional expeditions only being made from Russia and Norway.

The advantages offered by Spitzbergen as a location for the measurement of a polar arc were perceived by Sabine as long ago as 1831, but his suggestion was not followed by the British government. In 1861, as a result of a proposition made by Otto Torell to the Academy of Sciences of Stockholm, preliminary reconnoisances were made by Chydenius and Dunér, and later by Nordenskjold and Dunér, these showing that it was possible to select a number of elevations, all on or near the coast, and thus readily accessible, permitting the construction of a system of triangles extending from South Cape (76° 30′) to Little Table Island (80° 50′), thus permitting the measurement of an arc about 4 degrees in length. When it is realized that the original arc measured by Maupertuis in Lapland was but 57 minutes in length and that even when prolonged by Struve it was extended to 70° 40′ north latitude only, the advantages to geodesy by the accurate determination of the longer arc in the much higher latitude will at once be seen.

In 1897 the Academy at Stockholm proposed to the Imperial Academy at St. Petersburg that the work should be undertaken jointly, this being especially desirable since the islands are claimed to be Russian territory. The proposition was accepted and the work placed in the hands of two commissions, appointed by the Emperor Nicholas II and by King Oscar II. After some preliminary work in 1898, the main expedition started in 1899, equipped not only for the geodetical part of the work, but also for general scientific research, including the botany, geology, zoology, and meteorology of the islands, a portion of the staff arranging to winter there for the purpose.

As an indication of the high scientific character of the work it may be mentioned that on the part of Russia it was under the supervision of M. Backlund, the director of the observatory at Pulkova, with the assistance of MM. Pedachenko and Hansky, the latter being the author of the papers now under consideration, while among the Swedish observers may be mentioned M. Jäderine, the originator of the valauble method of base line measurement by wires, as well as the astronomers Angstrom, Rubin, Larsen, and Frenckel.

Apart from the obstacles due to climatic conditions, the work in Spitzbergen did not differ materially from geodetic triangulation in other parts of the world. The principal matter of engineering interest is the successful use of the 36 per cent, minimum-expansion alloy for the wire used in the base-line measurement, in connection with the Jäderine system.

The original method of Professor Jäderine involved the use of two wires, one of steel and the other of brass, both subjected to the same tension, and both provided with short graduated scales attached to the ends. By measuring the base simultaneously with both wires, the difference in the readings from the two wires gave the data necessary for the temperature correction. This method, using wires of 25 metres in length, is far more rapid than the former one using compensated bars, and the degree of precision has been found to be quite within the limits demanded to make the base measurement as accurate as the angular measurements. The discovery, by Professor Guillaume, of the fact that the alloy of 36 per cent. nickel and 64 per cent. steel possesses a remarkably low coefficient of expansion, about one-fourteenth that of platinum, has made it possible to use a single wire, since the temperature variations of a measuring wire, when protected from the rays of the sun, or used at night, are so slight that no correction is necessary. The Spitzbergen expedition used the Jäderine system with single wires of nickel steel, and the result, according to M. Hansky, has demonstrated a degree of precision within 1-400,000. The base of 6 kilometres was measured in four days, working each day from eight o'clock in the evening until three or four in the morning.

The rapidity of this work can be appreciated only when the condition of the ground is taken into consideration, the operators wading in mud and water knee-deep, on portions of the base.

The triangulation was conducted without serious difficulty other than that encountered in some places in the construction of the monuments from which the observations were made, it being necessary in some instances to avoid locations deeply covered with ice. With the co-operation of the Swedish expedition, however, all the triangulation was finished toward the close of 1901, including the measurement of a second base, and it is expected that the computations will be completed in about a year from the present. This will give the length of an arc of the meridian of about 4° 10′ in length, at a much higher latitude than has heretofore been measured, and the result must be a valuable contribution to terrestrial physics and geodesy.

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# MODERN MARINE BOILERS.

### A COMPARISON OF THE ADVANTAGES OF THE CYLINDRICAL MARINE BOILER WITH PRESENT FORMS OF WATER-TUBE BOILERS.

*H. M. Rounthwaite—Junior Institution of Engineers.*

SO much has been said of late about the relative merits of cylindrical and water-tube boilers for marine service, that the subject may seem rather threadbare, but in matter of fact it is one to which too much study cannot be given, since upon the satisfactory solution of the problem depends the determination of marine and naval strength and even supremacy. It is especially typical of modern development that the most important features in naval development to-day are its engineering questions. The subject of the training of naval officers is discussed elsewhere in this issue, and here we shall examine the paper of Mr. H. M. Rounthwaite upon modern marine boilers, recently presented before the Junior Institution of Engineers.

Mr. Rounthwaite makes no question about the fact that he is a consistent advocate of the cylindrical "tank" boiler, and that he does not believe in the water-tube type; and in his paper he proceeds at once to make a series of comparisons between the two types, showing the defects inherent in water-tube boilers generally, and also the extent to which cylindrical boilers are free from those defects.

The first feature to be examined is that of the provision for the combustion of the fuel. In the cylindrical boiler internal firing is employed, and hence there is no necessity for providing an external casing about the furnaces, and nowhere is there a higher temperature externally than that of the steam and water. With the water-tube boiler, on the contrary, the whole boiler must be enclosed in a casing capable of resisting the full heat of the fire, and which must at the same time be practically air tight in order that the outside air may not leak in to chill the surfaces and affect the combustion. In practice such casings have a very short life, owing to the action of the intense heat within, while any attempt to cool them by external air circulation results in the loss of much heat, since only a portion can be utilized for a hot air supply to the furnaces. It is very difficult to maintain the casings in an air tight condition, and the consequence of the inevitable leaks is a reduction in the efficiency of the boiler.

Mr. Rounthwaite compares the character of the combustion in the two types of boiler, showing that the arrangement of the tubes directly over the fire in most forms of water-tube boiler prevents complete combustion. The result is the production of an excess of carbon monoxide, and in addition to the loss in efficiency the gas is apt to re-ignite in the uptake, to the material injury of parts not intended to be exposed to such temperatures.

The relative efficiency of the heating surfaces in the two forms of boiler is also considered and it is maintained that the surface of the tubes of a water-tube boiler is only about 66 per cent. of an equal area in the cylindrical type. The difficulty of cleaning the tubes of water-tube boilers also tends to make them grow less efficient than the corresponding portions of cylindrical boilers, so that the difference in boiler efficiency increases with the length of a cruise.

Questions of deterioration and repair are also cited as being in favour of the cylindrical boiler, the tubes of water-tube boilers being especially liable to corrosion, and difficult of replacement. The great number of joints renders the water-tube boiler especially liable to leaks, and experience has shown that the quantity of water required to replace leakage is much greater with the water-tube than with the cylindrical boiler.

While there is much truth in many of the points which Mr. Rounthwaite has made against the water-tube boiler and in favour of the cylindrical type, there is much to be said upon the other side. In the first place it is not possible to stand still. The cylindrical boiler has apparently reached its limit of dimensions and strength, and higher steam pressures and more rapid steaming are demanded and must be supplied from some source. However satisfactory the cylindrical boiler may be for steady and continuous service, and its continued employment in the finest vessels of the merchant marine testifies to this, no more can be expected from it. Both types have their defects, neither of them at present is completely satisfactory, neither of them can in its present form expect to remain acceptable for naval service under present and future conditions.

The investigations of the Admiralty boiler committee, which have been fully discussed in these pages, show how fully all the points made by Mr. Rounthwaite are already appreciated by naval engineers, but they also show that the cylindrical boiler is not able to meet the demands which are before the designers of naval machinery for higher pressures and the more rapid generation of steam. The necessity for the use of small tubes with the water inside of them is a consequence of the inability of larger shells to stand the pressure without becoming excessively thick. How such water tubes shall be arranged so as to form them into an entirely acceptable boiler for naval use has not yet been fully determined, although many of the elements in such a boiler design have been worked out as a result of experience with imperfect forms. That the coming boiler must consist of such water tubes, however, may be received as an accepted fact, and no showing of the superiority of the cylindrical boiler over the present forms of water-tube boilers can alter the fact. Speed is an absolute necessity in modern naval design, and speed means power. Greater power can be obtained only by improvements in engine and boiler design, and experience has demonstrated that it is along the lines of higher pressure and higher temperatures that greater power and higher efficiencies are to be had in steam engines. These facts being admitted the cylindrical boiler is manifestly out of the race for such work. It will doubtless long remain the accepted form for merchant vessels and for naval service where the highest speed and power is not essential, but it must fall back into the second place, notwithstanding its long and satisfactory record.

Under such conditions there is little doubt that the change should be made gradually, and that the Admiralty plan of equipping vessels with boilers of both types is eminently wise and proper.

The presence of the cylindrical boilers will insure the maintenance of a certain proportion of the power for general cruising and for port service, while the water tube boilers of various designs can be tested under the conditions of actual service and thus be placed in a situation in which the best type will be evolved by a process of natural selection similar to that from which the cylindrical boiler itself was developed. Doubtless mistakes will be made and money expended, but the result will be a water-tube boiler which must prove acceptable because it will be the survival of the fittest among the products of the ablest practical and scientific engineers of the time.

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# WATER WASTE IN CITIES.

### EXPERIMENTAL METHODS EMPLOYED FOR THE DETECTION OF WASTE IN THE DISTRIBUTION SYSTEM OF NEW YORK CITY.

*Engineering Record.*

THE question of the waste of water in large cities is most important, especially in view of the demand which is being made everywhere for purer water and the introduction of filtration processes. When there is an ample supply of pure water at hand little attention is paid to the reckless waste which takes place, and thus the community becomes accustomed to per capita consumptions which are out of all proportion to the real amounts needed or really used. As the supply becomes polluted and necessity arises for purification of for the derivation of a new supply it almost invariably becomes necessary to consider the reduction of waste, in order that the real necessities of the population may be intelligently determined. At the present time the whole question of the water supply of New York City is under consideration of a special board of experts, and a valuable preliminary to their researches will undoubtedly be the investigation which the commissioner of the department and the chief engineer are conducting to determine the actual amount of waste now existing.

The method in use, as described in a recent issue of the *Engineering Record,* is that of measuring the flow in the mains by means of a modification of the well-known Pitot tube, and comparing the day and night flow, together with a consideration of the metered consumption. The actual instrument used is known as the Cole-Flad pitometer. This consists of an arrangement of two tubes of which the ends are bent at right angles to the principal length, these being inserted into the main so that one pipe has its end turned against the current of the water and the other pipe is turned with the current. The difference of pressure in the two tubes is measured by connecting them to a U tube containing a mixture of carbon tetra-chloride and gasoline, this having a specific gravity of either 1.25 or 1.5 according to circumstances. The displacement of the liquid in the U tube is a measure of the pressure produced by the current, as distinct from the total pressure in the main, and by the use of tables or curves the quantity of water flowing through the main can be closely computed from the indications of the instrument. Since it is important to obtain records of the flow at various portions of the day the instrument is provided with a photographic recording attachment, so that when once connected the pitometer may be left attached all night, and the record made upon a moving band of photographic paper taken off in the morning and preserved for reference and computation.

"The system as applied in New York is as follows: The city is divided into large districts, the boundaries of which are so selected that the entire water supply for each can be made to pass through one or two large mains. These mains are tapped under pressure and a 1-inch corporation cock attached, through which the tubes of the pitometer are inserted when it is desired to obtain a record of the quantity of water flowing into that district. The instrument gives a continuous record of this quantity. At the same time inspectors are sent around to obtain the figures for the quantity of water supplied to the district through meters. The population of the district is also obtained, either from the city census records or by the inspectors, who also obtain as accurately as possible the figures for the non-resident population and any other significant data.

"The total metered consumption of the district being deducted from the total amount supplied to the district as measured by the pitometers, the difference shows the amount of unmetered consumption plus the waste. Under ordinary conditions, this difference for the hours of 2 to 4 a. m. measures the amount of waste in the district. Local conditions may modify this conclusion, however, as in the case of one of the districts considered in New York where the pressure is not great enough to supply the upper floors of the buildings during the day, and especially in the large apartment houses tanks have been provided on the top floors, which are filled during the night for use the next day. Special conditions like this may affect very appreciably the night consumption of water, and it requires considerable experience to be able to interpret correctly the results of such investigations. If the amount of waste and leakage is found to be enough to warrant further investigation, the large district is subdivided into smaller ones and a similar process is followed until the trouble is located."

Several reproductions of the photographic records of the apparatus are given from the report of the official tests in New York, and the results are interesting. Thus an 18 hour record of a 12 inch main in the heart of the city showed that all night long the rate of flow through the pipe did not fall below 1,700,000 gallons per 24 hours, while the maximum day flow was at the rate of only 2,070,000 gallons. The large night flow was undoubtedly due to the filling of large tanks in hotels and apartment houses for use the next day, showing the extent to which this practice equalizes the demand upon the water supply system. Reports from several of the districts of New York are already complete, and the principal results are given in condensed tabular form. On the whole the wastage appears to be principally in the buildings, due to defective plumbing, and one of the immediate results of the work has been the correction of many such defects. There is a marked difference in the per capita consumption in districts of different character. Thus in an excellent residence district the per capita consumption, including waste, ranges from 175 to 223 gallons per day, while in a tenement district it falls to 37 gallons. Doubtless the reasons for this are apparent to those who have made the inspection of the respective sections of the city, and when the work is fully completed it may be possible to discover some definite relation between the character of the districts and their relative water consumption.

## THE FUTURE OF GAS LIGHTING.

DEVELOPMENT OF COAL GAS AND ALLIED ILLUMINANTS—HIGH CALORIFIC POWER DESIRABLE FOR INCANDESCENT BURNERS.

*Prof. Vivian Lewes—Society of Arts.*

GAS lighting presents a most interesting phase in the history of applied science, affording in itself an excellent example of the manner in which apparently insuperable obstacles have been overcome by the use of scientific methods in commercial operations.

Those who can recall the flurry which followed the introduction of electric lighting, when it was supposed for a time that lighting by gas was doomed, will appreciate the position which illumination by gas has since attained, and there is every reason to believe that continual improvements will continue to make gas a successful competitor with other methods of producing artificial light.

The interesting lectures by Professor Vivian B. Lewes, delivered before the Society of Arts, and published in the *Journal* of the society, give an excellent idea of the improvements which have been made in gas lighting in recent years, and indicate clearly the lines along which progress may be expected.

The weak feature in gas lighting for a long time lay in the very imperfect methods used in burning it, gas of excellent illuminating power being used in burners which utterly failed to utilise the fair value of the gas. This fact was hardly understood, even by those who should have known better, so that there was a continual demand for a richer gas, with the idea that this would provide a better light in the defective burners then in vogue.

When, however, the Welsbach incandescent mantle was perfected, in 1892, a new era in gas lighting was begun, an era which has opened up lines of development which are far from being exhausted. Professor Lewes describes the Welsbach mantle as being simply an improved method of enrichment of the gas. The illuminating power of coal gas is well known to be due to the raising of particles of solid carbon to incandescence. Enriching the gas means simply providing a greater proportion of carbon to become incandescent. Instead of putting the incandescent material in the gas, Dr. Welsbach hung it over the flame once for all, or at least for a comparatively long period, thus enabling a gas low in carbon particles to emit a brilliant light. Apart from the brilliancy of the illumination thus secured, the important feature of the incandescent system is the fact that it permits the successful use of a non-enriched gas and thus enables a marked reduction in the cost of illumination to be secured. The Welsbach burner itself uses far less gas for a given illuminating power than is possible with other forms of burners, but apart from this advantage, its illuminating capacity does not depend upon the richness of the gas, but upon its calorific power. Since it is altogether possible to make cheap gas of high heating value it is of great importance that the incandescent burner shall come into universal use, so that a gas of low illuminating power and high calorific value may be acceptable to all customers.

At the present time some legislation may be necessary to permit this desirable result, since present enactments provide for a standard of illuminating value for coal gas, below which standard the manufacturers may not go. This standard is a photometric one, being, in England, a value of 16 candles when used in a standard argand burner. In order that possible economies may be attained and a corresponding reduction in the price of illumination be secured, there should be a new standard adopted, based upon the performance of the gas in some form of modern incandescent burner, and ultimately this will doubtless be done.

Admitting the importance of producing a low-priced gas of high calorific value for use with incandescent burners, Professor Lewes proceeds to show how this may be obtained by the admixture of water gas with ordinary coal gas. Water gas, produced by passing steam through incandescent coke or anthracite, contains about 52 per cent. of hydrogen and 38 per cent. of carbon monoxide, with small quantities of carbon dioxide, oxygen, and nitrogen. Of high calorific value, this gas requires carburetting before it can be used directly as an illuminant, and, thus enriched, it is used in many places, notably in the United States. Used directly as a diluent for ordinary coal gas, however, it would serve to diminish greatly the cost, and at the same time enable an excellent calorific value to be maintained, although the illuminating value would be lowered when used in ordinary flat-tip burners. With Welsbach mantles, however, such a mixed gas furnishes a brilliant light, enabling the cost of lighting to be reduced to a point where competition appears to be practically impossible.

The great objection to this method of obtaining cheap lighting is the proportion of carbon monoxide in the gas. The poisonous nature of this gas is well known, and many objections have been made to the permission to distribute such a mixture throughout cities, because leaks would be far more generally fatal than with the less poisonous coal gas. Professor Lewes shows that this objection is not nearly so serious as at first appears. Ordinary coal gas contains from 5 to 10 per cent. of carbon monoxide in nearly every case, and Professor Lewes maintains that practical safety is not further endangered if the proportion does not exceed 16 to 17 per cent. If the limit is fixed at 16 per cent., it would be practicable to take an ordinary coal gas, containing 5 per cent. of carbon monoxide, and increase its bulk by the addition of carburetted water-gas until the mixture contained 52 of coal gas and 48 of carburetted water gas. If blue water-gas were used the limit would be reached when the mixture contained 66 per cent. of coal gas, and 34 per cent. of blue water-gas. Thus, to 100 volumes of coal gas there may be added 92 volumes of carburetted water-gas, or 51.5 of blue water-gas before the limit of 16 per cent. of carbon monoxide in the mixture is reached.

Such a gas is naturally best suited for use with some form of incandescent mantle, and Professor Lewes discusses a number of investigations both in Europe and America which show conclusively that under such conditions the light emitted is practically proportional to the calorific power of the gas, and that its illuminating power as ordinarily understood does not bear upon its value for use with mantles at all.

So far as the mantles themselves are concerned, improvements are to be expected from the various fibres which are now the subject of experiment. The composition itself, consisting of 99 per cent. thoria and 1 per cent. ceria, appears to be the best which can be obtained with present knowledge. The Welsbach mantles use cotton fibre, but the Lehner fabric, composed of artificial silk, made from collodion, gives a more brilliant light and a far longer life, but such mantles are naturally more expensive than those made on a cotton fabric. The experience of Buhlman, of Berlin, with mantles made on ramie fibre, have given most encouraging results, and microscopic enlargements of the various mantles, before and after burning off the combustible portion show the differences in structure very clearly.

These lectures, covering, as they do, the latest state of the art of illumination by gas, should stimulate progress in the direction of improvement, both in the supply of a gas of high calorific power at a moderate price, and in the introduction of high-grade incandescent burners in which to use it.

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## PROBLEMS IN AERIAL NAVIGATION.

### AERODYNAMICS AND THE INFLUENCE OF WIND FORCES UPON THE DEVELOPMENT OF BALLOONS AND AEROPLANES.

*R. Soreau—Société des Ingenieurs Civils de France.*

AMONG the numerous discussions which have appeared of late concerning the problem of aerial navigation, by far the greater part have been empirical in their character, relating to details of the constructions of machines or to their experimental operation with but little regard to the scientific principles involved in the work to be accomplished. Under such circumstances the scholarly paper recently presented before the Société des Ingénieurs Civils de France by M. R. Soreau, and published in the *Mémoires* of the society, is most welcome, constituting as it does a résumé of our present knowledge of the science of aerodynamics and the part played by the wind in the problem of aerial navigation. The valuable paper by Mr. Neilson in our issue of January last shows how imperfectly the action of wind forces upon stationary structures has been understood, and it is not surprising that the behaviour of air currents above the surface of the earth should be a matter of uncertainty. When we consider the movements of the air with relation to objects fixed upon the surface of the earth we find many phenomena produced solely by the fact that the motion of the wind is opposed by the structures with which it comes in contact. An object floating above the surface, however, is entirely immersed in the mass of air, partaking of its movements much in the same manner as the passenger in the railway train moves about unconsciously while going at express speed, and there is no appreciable resistance of any sort. Thus, if we can imagine two balloons floating side by side in a current of air, one of them, if provided with propulsive machinery, may circle about the other or perform various evolutions with regard to it, quite independently of the velocity of the common current in which they are both immersed, and altogether regardless of the direction of motion with regard to the surface of the earth beneath.

It is only when an attempt is made to direct the machine as regards the position of objects which are not moving in the same current of wind that the difficult element of opposing wind resistance must be encountered, the only air current otherwise met being that due to the movement of the balloon itself. For these reasons it is a mistake to consider the movements of the air with regard to the ground in considering the motion of a machine through the air. M. Soreau discusses the effect of sudden squalls, and of the variations in the velocity of air currents treated by Professor Langley in connection with the internal work of the wind, showing the action of such variations as affecting the problems of sailing flight.

Considering the dirigible balloon, one of the most important problems is that of its stability, as has appeared both from theoretical and practical considerations. An important element in this respect is the completeness with which the gas bag is distended; and the introduction of the *ballonnet,* or internal balloon, capable of being distended by pumping air into it, is a valuable detail in modern balloon construction.

The difficulties of pitching, which have appeared conspicuously in connection with the spindle-shaped balloons generally used in modern experiments, are partly remedied by the use of the ballonnet, but much may also be accomplished in this respect by the exercise of judgment in determining the shape of the gas bag affecting the position of the centre of pressure. Thus Col. Renard, in the famous dirigible balloon, "La France," which operated successfully as long ago as 1884, used a gas bag in which the greatest diameter was well forward of the middle of its length, and by placing the rudder in the rear and the propeller in advance, a fair degree of stability was secured. The use of internal partitions in the gas bag has been found to diminish the pulsations otherwise contributing to instability. The guide rope, used by Santos-Dumont, is considered by M. Soreau as undesirable, introducing the periodical action of the pendulum into the vibrations in an objectionable manner.

In discussing the aeroplane, as the probable successor of the dirigible balloon, M. Soreau shows that the former may well be considered as derived from the latter. Making the gas bag of a dirigible balloon of more resistent material, and inflating it to a high degree of tension, we have to a certain extent a supporting surface apart from the fact of its ascensional force. When this is propelled at a sufficiently high rate of speed certain vertical reactions are produced, according to the shape of the balloon, but of the same general character as those sought in the aeroplane.

Considering the aeroplane generally, M. Soreau calls attention to some important principles affecting its construction. Thus, the limits of the angle of inclination are very small, ranging between a few degrees only. If a greater angle is taken the air strikes the wings from below, and a sudden fall follows, as was the case with Lilienthal in his fatal experiment. If, on the contrary, the angle is too flat, the aeroplane will make a gradual, sloping descent. The question of stability is also a difficult matter. The bird, having independent control over both wings, can vary the position of either, and thus correct its balance as may be necessary, as regards transversal position. So far as longitudinal stability is concerned, it depends upon the relation of the centre of pressure to the centre of gravity, the couple varying according to the inclination of the aeroplane. M. Soreau rightly calls attention to the mistake which may be made in carrying imitations of the bird too far, and as he says, it would be as illogical to attempt to imitate the movements of the wings of a bird in flying as to copy the motions of the legs of a horse in designing an automobile.

The closing portion of the paper of M. Soreau consists of an excellent treatise on aerodynamics, of which we can give but a brief abstract here. The laws of the resistance of the air are but imperfectly known, as indeed are those of fluids generally. In view of the difficulties which surround the study of hydrodynamics it is not surprising that the motion of a solid through the air should require study and experiment. Taking the experiments of Marey, Canovetti, and Le Dantec, it is shown that the resistance to the movement of a body through the air is directly proportional to the area, and proportional to the square of the velocity. When the surface is inclined to the direction of motion, however, the question becomes more complicated, and suction may be produced in consequence of the reaction of the displaced filaments, in a manner similar to that found by Irminger in the action of wind upon large gas holders.

This action is much less apparent with surfaces of small size than with larger ones, and hence it is advisable to use a number of small planes, which may be conveniently arranged in a manner similar to the well-known Venetian blind.

The theories for the action of a current of water upon an inclined surface, as deduced by Beaufoy, Gerlach, Joessel, and Rayleigh, are discussed, but the experiments of Langley show that these are not applicable to the air. Langley's experiments are discussed at length and reduced to a general formula as well as to a diagram giving the relation of the sustaining power at various angles to a normal pressure upon a plane. This portion of the discussion may well form a starting point for future experimental researches, and constitutes a valuable contribution to the little-studied science of aerodynamics.

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# IMPROVEMENTS IN INTERNAL-COMBUSTION MOTORS.

## RECENT EXPERIMENTS WITH THE IMPROVED BÁNKI MOTOR, USING GAS AND LIQUID FUELS.

*E. Schimanek—Verein Deutscher Ingenieure.*

WE have referred in these columns already to the improved internal-combustion motor designed by Herr Donat Bánki, of Budapest, and the excellence of the results which have been attained with recent forms of this engine renders it a subject for comment, especially in the light of tests made by Professor Schimanek, published in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure.*

It is well known that one element in high thermal efficiency of internal-combustion motors is the use of high compression of the charge prior to ignition. The usual limit to high compression is the igniting temperature of the charge, and, in fact, explosions of air compressors have taken place by reason of the heat of compression vaporizing and igniting the heavy oil used as a lubricant. The Diesel motor utilises this fact as a means of igniting the charge, but in that type of motor the air is compressed alone, the fuel being injected only after the full compression pressure has been attained, and hence the limit to the compression is found, not in the ignition temperature of the charge but in the mechanical details of construction.

When the charge of gas or vapor and air is drawn into the cylinder in a mixed condition, ready for ignition it can be compressed safely only to a point below its igniting temperature, otherwise detrimental and even dangerous pre-ignition will occur. In order to permit the use of high compression without the danger of premature ignition, Herr Banki adopts the expedient of injecting into the charge a spray of water, atomized into finely divided particles like mist, and mingled with the charge as it is drawn into the cylinder. The presence of the moisture raises the ignition temperature of the mixture very materially, so that not only is there no danger of premature explosion, but the aid of a hot tube is required to ignite the charge at the proper time to produce the propelling explosion. The moisture present in the cylinder expands with the heat of the explosion and adds its expansive force to that of the charge, thus returning as power the heat which it has absorbed, and hence the thermal efficiency of the machine is practically unaffected by the presence of the water.

The use of water in the cylinder of an internal-combustion motor is by no means new, having been used in the old Hugon engine shown at the Paris exposition of 1867, but it was there employed only to cool the cylinder, as a substitute for the water jacket. In the Bánki motor, however, the water jacket is retained, and the finely atomized water is considered as a portion of the fuel charge.

Professor Schimanek examines the thermal conditions dependent upon the use of different percentages of moisture, for a compression of the charge to one-tenth of its initial volume, and shows that for constant specific heat the temperature of the charge without the water would be 1030°C., giving a theoretical thermal efficiency of 61 per cent., while with a ratio of 0.08 of moisture to air, by weight, the temperature of compression is lowered to 530°C., and the theoretical thermal efficiency still remains as high as 58.4 per cent.

Professor Schimanek describes in detail tests upon Bánki motors using as fuel benzine, alcohol (spiritus), and gas, tabulating the results very fully. Indicator diagrams show a compression pressure of 12 to 15 atmospheres and explosion pressures of 35 to 40 atmospheres, while the thermal efficiency per brake horse power was as high as 31 per cent.

The improvements in the present motors over those of earlier design are mainly in mechanical construction, and in the apparatus for spraying the water into the entering charge, the principle of the machine being practically the same as that originally show at the Paris exposition of 1900. The present engines, however, are of small power, ranging from 3 to 10 horse power, which renders the big thermal efficiency the more notable.

An interesting phase of the experiments, described by Professor Schimanek appears in the adaptation of the principle to the motor of an automobile. A gasoline vehicle of the well known de Dion-Bouton construction was taken and the cylinder head of the engine removed and replaced by another constructed so as to increase the compression from 1:3.6 to 1:5.81, and a device for spraying water into the charge was attached. Brake tests of the motor showed an increase in capacity of about 30 per cent., while the cooling effect of the water was very marked. It is probable that this principle may therefore prove of value on connection with motors of vehicles as well as for stationary service.

While the principle of injecting or spraying water with the charge of internal combustion motors may prove advantageous in permitting the use of higher compression ratios, it appears to be limited to a certain class of fuels which are still ignitable under the conditions then existing. The original motor of Bánki operated with benzine only, while those tested by Professor Schimanek used benzine, a mixture of alcohol and wood spirit, and also gas. With heavier fuels there may be found difficulty in igniting at all and it seems as if the method is applicable only to engines using gas, or the lighter hydrocarbons. The experiments with the de Dion-Bouton motor showed that the presence of the moisture did not interfere with the electric ignition, which confirms the practicability of employing the system for automobiles, but the great demand is for an engine which will be able to use the heavy oils, such as kerosene, petroleum residue, and similar fuels, which at the present time require either the use of some form of vaporizer, or such high compression temperatures as are employed by Diesel.

All these experiments are on the right track, however, and there is little doubt that the pressure which is being exerted upon the problem of the perfection of the internal-combustion motor will result in many advances, in both mechanical and thermal features.

## MOTIVE-POWER MACHINERY IN AMERICA.

### THE PRESENT STATUS OF STEAM, GAS, HYDRAULIC, AND OTHER PRIMARY POWERS IN THE UNITED STATES.

*Edward H. Sanborn—U. S. Census Report.*

ALTHOUGH it has thus far proved impracticable to obtain census figures showing the complete status of any department of industry at any one time, yet the results of the census of 1900, now being given to the public contain much valuable information, and cover enough ground to enable some very useful conclusions to be drawn.

The report of Mr. Edward H. Sanborn, upon motor-power appliances, admittedly covering only about one-third of the aggregate value of the products of the establishments from which the data were derived, cannot be used to deduce relations of wages, capital, or labor, but it will be found valuable as regards the products themselves. Taking the census year, 1900, only into account, the following general results may be abstracted from Mr. Sanborn's report:

By far the greatest amount of power machinery produced during the year was for use with steam. Thus there were 40,533 steam boilers, aggregating nearly 3,000,000 horse power, produced, and 29,120 steam engines, representing a little more than 2,000,000 horse power. Of other kinds of power machinery there was about 165,000 horse power of internal-combustion motors, and 370,000 horse power of hydraulic motors.

The distribution of this large amount of power among machines of various types is a matter of much interest, as bearing upon the development of improvements in different lines. Thus almost exactly one-third of the boiler horse power constructed was of the water-tube type, the water-tube units averaging four times the size of the fire-tube boilers. Steam engines are classified according to the well-known types of plain slide-valve, high-speed automatic, and low-speed automatic. Of the first class there was about 650,000 horse power built, mostly in small sizes, averaging 30 horse power; of high-speed automatics about 300,000 horse power is recorded, in units averaging 82 horse power; while of the slow-speed automatic engines, such as the Corliss there was built nearly 850,000 horse power, mostly in large units for power stations, rolling mills, and other heavy work.

Internal combustion engines, other than those used for automobiles, footed up 164,000 horse power, the average unit being about 9 horse power, while turbine water wheels represent about 300,000 horse power, this last quantity being very indeterminate, however, owing to lack of information as to the head of water under which some of them were to be used.

The data as to the cost of equipment is interesting and shows the extent to which modern methods of manufacture have affected the prices of motive-power machinery. Thus, fire-tube boilers cost $9.28 per horse power, while water-tube boilers averaged only $7.73, this difference being doubtless partly due to the fact that the latter type was built in larger units. For steam engines the prices for the types of plain slide-valve, high-speed automatic, and low-speed automatic, are respectively $12.11, $10.43, and $11.59, per horse power. The small size of the internal combustion motors brings their cost up to $33.88 per horse power, besides which it must be remembered that having but one power stroke in every four, such engines are necessarily larger for their power than steam engines. Since they do not require any steam generator, however, they may be compared with the cost of both engine and boiler in considering the installation cost of a power plant.

The report contains interesting tabulated information as to the manufacture of power machinery classified by states, and is an important document for study in connection with the development of manufacturing industries by geographical locations. For this the reader must be referred to the original report. It is worth mentioning, however, that the total output for the year 1900 was primary power machinery representing 2,743,325 horse power, with a value of $35,120,218. This does not include locomotive engines, nor motor vehicles, but does include marine machinery.

Considering the development of power machinery during the decade covered by the census, some interesting features are noted.

In steam machinery the improvements have been mostly in matters of detail dependent upon local conditions. Water-tube boilers are increasing in use, and superheating is more generally considered of late, although by no means so much used as in Europe. Mechanical stoking is becoming more general in cities where smoke prevention ordinances are enforced. In both engine and boiler practice modifications have been introduced in response to the demands of the large power house erected for electric power generation. Boilers are installed in larger units, and the houses are equipped with conveying apparatus for coal and ashes. Direct-connected electrical generating sets, with the dynamo rotor mounted upon the engine shaft, have included the design of engines from 5,000 to 8,000 horse power rated capacity, these engines being almost universally of the compound type, with trip valve gear and condensation. The triple expansion engine, while holding its own in marine practice, has been generally superseded in stationary practice by the compound engine, with cylinder ratios of larger value than formerly, ranging from 1 to 4 up to 1 to 7, this latter proportion being practically the same as that existing between the high and low pressure cylinders of a triple-expansion engine, the intermediate cylinder being omitted. The steam economy is almost the same in the case of the triple and the compound engines in the latter case, while the machine is materially simplified in construction and operation.

The steam turbine is taking its place as an article of manufacture, being now well past the experimental stage, and it will doubtless figure in a large degree in the statistics of the next 10 years.

In like manner there has been a marked activity in the development of internal-combustion engines, and units up to 1,000 horse power, for use with blast furnace gas are under construction. This form of prime mover bids fair to displace the steam engine in many situations, and holds out greater promise of economy than any other motor.

The development of water power for the generation of electricity at moderate cost has led to a revival in the use of water power, the plant at Niagara being extended and work on the Canadian side being well under way. The possibilities of the utilization of high heads of water with moderate volume has led to the development of impact wheels of moderate size and cost and of high efficiency, and the conditions attending the use of jets of water at great velocities have materially modified the methods of governing the speed of such motors.

The whole report of Mr. Sanborn is a most valuable contribution to the statistics of engineering, and its wide distribution and study should lead to a full appreciation of the importance of collecting such information in all departments of industry.

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# METAL-WORKING TOOLS.

## THE INFLUENCE OF CUTTING ANGLES, MATERIAL, AND TREATMENT UPON SPEEDS AND FEEDS FOR METAL-WORKING TOOLS.

*H. F. Donaldson—Institution of Mechanical Engineers.*

AN important element in successful works management consists in the ability to extract the greatest possible output from the machines with which the work is actually performed. In the average shop, under what was formerly considered good management, the establishment charges, including everythisg which could not be directly classed as productive, amounted to about as much as the wages of the productive workmen. That is, the shop cost of an article consisted of the material, the wage cost and an expense burden equal to the wage cost. It is now well understood that the most effective method of reducing the shop cost of an article is to reduce the relative expense burden by increasing the output, the burden remaining nearly constant, and therefore the proportion to be borne by each element of the product diminishing. It is therefore most important that the tools with which the work is performed should be operated at the highest degree of efficiency, and every means which can be reasonably employed to secure the best operative results must be welcomed.

In a paper recently presented before the Institution of Mechanical Engineers by Mr. H. F. Donaldson, the influence of the cutting angles of tools for metal work, as affecting speed and feed is discussed in the light of experiments conducted by the author, and some interesting facts brought out. Since a tool is made to cut, the conditions under which it can cut to best advantage must be ascertainable. The variable elements in the tool itself are the material of which it is made and the shape which is given to it, or the angles to which it is ground. These are again dependent upon the nature of the material to be cut, the speed at which the cut is made, the depth of cut, and the rate of feed. In many shops the angles given to the tools are those determined by the experience of the workmen themselves, and skilful workmen are able to secure fairly close approximations to the proper combinations of tools angles to suit their work, but it is by no means common to find a man who can name the angles at which he aims when grinding, and still more rare to find one who is provided with any means of checking the correctness of his grinding, if he knows exactly what he wants.

All this Mr. Donaldson rightly considers as unsatisfactory, believing that the proper method is to determine the proper angles to which tools should be ground for various kinds of work, and to do the grinding altogether upon machines which will insure the accurate reproduction of the desired angles. The variation in the tool angles is always dependent on the nature and hardness of the material to be cut; this is especially the case in the cutting angles, but the influence and effect of the depth of cut and the fineness or coarseness of the feed must not be overlooked. There are indications in Mr. Donaldson's experiments that a light cut and a fine feed should be attacked with a sharper angle than would be permissible with a heavy cut and a coarse feed. Experience goes to show that if the work will stand it, a heavy cut and slow speed will be more efficient that a light cut and quick speed, even though the result should apparently be the same.

The experiments conducted by Mr. Donaldson covered fourteen qualities of material, including steel, wrought-iron, cast-iron, and certain yellow-metal alloys. Upon these were made tests with pointed roughing tools, an ingenious form of pressure dynamometer being used to determine the effect of an increase in feed upon the pressure on the point of the tool. The desirability of making such measurements will be seen when it is realised that an increase of feed from 1/32 in. to 1/20 in. increased the pressure from 80 to 150 pounds per square inch.

In the original paper the best results selected from many tests are tabulated and arranged so as to show the nature of material, speed of cut, material removed, and general performance with regard to the angles used. The best angles naturally varied according to the hardness of the material cut. For the materials classified as hard, medium hard, and very hard, the best cutting angles appear to be 59°, 62°, and 75° respectively, for speeds of 10 to 15 feet per minute. These, however, are but general conclusions, and the tables should be consulted for closer details as to angles and speeds for various materials.

As a result of the experiments, it was found practicable to take the grinding of the tools altogether out of the hands of the men in a certain shop, and to have them ground to the proper angles in the tool room and issued as required. The materials were also classified and the correct speeds for each determined, and the foreman was required to see that the work was done according to the instructions. Under such a system it is not only possible to have the maximum efficiency reached, but also to obtain a knowledge beforehand of the time required for a certain operation, thus enabling closer estimates to be made and the result checked.

It is unfortunate that the experiments so carefully conducted by Mr. Donaldson did not include a close measurement of the power required for each test, as might readily have been done had the machines been operated by independent electric motors equipped with recording wattmeters. Doubtless his work will stimulate others to undertake similar tests, and contribute further additions to the common stock of information.

In an appendix to the paper Mr. Donaldson gives some information as to tests made upon the newer high-speed steels, and although the results are given as only preliminary, they are of interest. The important point brought out is that the high-speed steel which is the best for cutting mild material is by no means certainly the best for cutting very hard material, and vice versa. It is therefore especially important to take into account the nature of the material to be cut.

The great advantage of the high-speed steels appears in the cutting of materials of moderate hardness. Thus experiments show that the new steels show speeds of work nearly ten times faster than ordinary tools when working in moderately hard material, but only about three times faster when cutting the harder qualities of material. This may be because the steel makers have directed their attention more exclusively to the demands for the quick removal of large weights of mild or medium hard material, or it may be to a lack of realisation of the necessity for special qualities for cutting very hard material.

So far as the Taylor-White steel is concerned, however, its inventors distinctly announce that it is intended solely for use on roughing cuts, for the rapid removal of large amounts of stock on wrought or cast iron.

# THE CALIBRATION OF INDICATORS.

### DATA AND RESULTS OF INVESTIGATIONS UPON THE SPRINGS OF STEAM ENGINE INDICATORS AT VARIOUS TEMPERATURES.

*Physikalisch-Technisch-Reichsanstalt.*

WE noted in these columns a few months ago the paper of Herr Roser upon the various methods of testing the accuracy of the springs of steam engine indicators, showing the methods of calibrating such springs and of correcting the diagrams. Herr Roser's paper has brought out a comparison of the methods discussed by him with those in use at the Reichsanstalt, and in a paper by Messrs. Wiebe and Schwirkus, published in the *Zeitschrift des Vereines Deutscher Ingenieure* some notes of the work of the Reichsanstalt in this line may be taken.

In the first place there is no doubt that the readings of the instrument are affected by the direction of movement of the piston, but it does not appear that any direct relation can be discovered. Tests of several instruments, both new and used, show variations which may well be attributed to piston friction, the variations from the mean being from 3 to 4 per cent., taken at intervals of one atmosphere (metric) throughout the whole scale. By adjusting the instrument so that the reading is correct for the middle of the pencil movement the error may be minimised, and this is desirable in all cases.

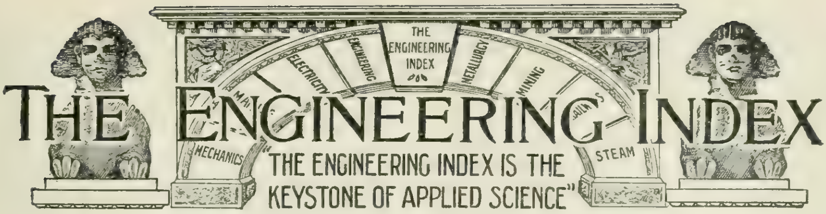
Tests under steam show results similar to those found by Bach, Slaby, and other investigators. In no case is it proper to assume that the temperature of the spring is that due to the steam pressure. If the indicator piston is very leaky, so that there is a free flow of steam past it, the temperature will approach that of the steam, but with a piston fairly tight experiments show that the temperature of the indicator spring is about 60°C. lower than that of the steam at the indicated pressure, this difference being nearly constant for pressures from 2 to 15 atmospheres. The temperature of the spring also varies at different points in the stroke, so that it is a matter which cannot well be determined in a form available for subsequent use in correction of diagrams. These facts render it difficult to make any calibration measurements of indicator springs under steam or other methods of heating, since the operative conditions cannot be exactly reproduced, and calibrations for one range of pressure and one rate of speed will not serve for another. In general it must be accepted that the temperature of the spring does not bear any direct or ascertainable relation to the mean effective steam pressure.

Tests have been made of certain forms of indicators in which the spring is placed outside the cylinder, and in such instruments the temperature of the spring is not affected to any extent which might change its action. Thus in such an instrument the application of a thermo-element for the measurement of the temperature of the spring showed a maximum of 54°C., when the surrounding air stood at 45°C.

In general, therefore, it may be accepted that there is a distinct variation between the indications of springs which are cold and those which are subjected to the action of steam, but that this difference can be determined only by testing each indicator for its own instrumental correction. While such a calibration cannot be made to cover all possible corrections it may minimise the errors very materially. It is evident, however, that the proper remedy is to remove the spring from the action of the steam, and this has already been done in several forms of instrument, and there are numerous ways in which satisfactory constructions might be imagined to accomplish this end.

The study which has given to the instrumental errors of the indicator show how absurd it is to carry out computations as to water consumption, horse-power, cylinder condensation, etc., to several decimal places when it is altogether possible that there are uncorrected errors in the diagrams amounting to more than unity in the original data. Any important work involving indicator diagrams should be accompanied with some information as to the manner in which the instrument has been calibrated if the results are to be accepted without reserve.

# THE ENGINEERING INDEX



"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a Descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

*We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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## CIVIL ENGINEERING

### BRIDGES.

**American Bridges.**

Bridge Building and Bridge Works in the United States. The first of a series of articles aiming to describe American practice in bridge design and construction, and the shop equipment and methods of American bridge works. 2500 w. Engr, Lond—Jan. 16, 1903. Serial. 1st part. No. 53086 A.

**Arches.**

Computations for Masonry Arches (Calcul des Ponts en Maçonnerie). H. Lossier. A review of the method of Ritter, treating of the distribution of forces in masonry bridges of several arches. 2000 w. Génie Civil—Jan. 3, 1903. No. 53214 D.

**Braced Arch.**

The Rio Grande Braced Arch Bridge, Pacific Ry. of Costa Rica. Illustrated detailed description of a two-hinged steel braced arch structure 685 ft. long and 340 ft. high from the rails to the water. 2000 w. Ry & Engng Rev—Jan. 24, 1903. No. 53173.

**Bridge Elevation.**

The Elevation of the Chicago and Alton Bridge at Bridgeport, Chicago. Illustrated description of the work of elevating a drawbridge 11 feet from the old foundation without interrupting river or railroad traffic. 600 w. Ry Age—Jan. 23, 1903. No. 53142.

**Cantilever.**

The Mississippi River Bridge at Thebes. Illustrates and describes a large cantilever bridge under construction for the purpose of forming a connection between railroads. It is especially notable by reason of the nature of its approaches which are to be entirely of concrete. 2700 w. R R Gaz—Jan. 9, 1903. No. 52926.

**Culverts.**

Determining the Size of Railroad Culverts. S. Whinery. Discusses the elements that must enter into such a computation, and method of arriving at the proper capacity. 4000 w. R R Gaz—Dec. 26, 1902. No. 52923.

The Design and Construction of a 50-ft. Brick Arch Culvert Across Rock Creek, Washington, D. C. W. J. Douglas. An illustrated article giving the history of the work and an account of its design and construction. 5200 w. Eng News—Dec. 25, 1902. No. 52872.

**Erection.**

Erection of the Northwest Miramichi Bridge, Newcastle. N. B. Illustrated detailed description of the bridges of the Intercolonial Railway, which cross the branches of the Miramichi River, and of the excellent state of preservation of the bridge which is being replaced, with particulars of the erection of the new structure. 2700 w. R R Gaz—Jan. 23, 1903. No. 53171.

**Girders.**

The Support of the Ends of Cross Girders. Brief illustrated descriptions of methods of carrying the ends of cross girders upon the main or longitudinal girder, with critical remarks. 1900 w. Engr, Lond—Dec. 26, 1902. No. 52699 A.

**India.**

The Rupnarayan Bridge; Bengal-Nagpur Railway. S. Martin-Leake. Describes the construction of this bridge which consists of 7 spans of 300 ft. and 4 spans of 100 ft. 1500 w. Engng—Dec. 19, 1902. No. 52688 A.

**Omaha.**

The Omaha Interstate Bridge. Illustrates and describes the old and new structures of the bridge between Omaha and Council Bluffs. The new bridge is now under construction without interrupting traffic. 4300 w. Eng Rev—Jan. 24, 1903. No. 53156.

**Pittsburg.**

Pennsylvania Company's Bridge at Eleventh Street, Crossing the Allegheny River. Antes Snyder. A brief history of the public improvements which formerly occupied the vicinity of the recently constructed double deck bridge at this point. Discussion. Ills. 5000 w. Pro Engs Soc of W Penna—Nov., 1902. No. 53037 D.

The Monongahela Bridge. An illustrated detailed description of a double-track bridge having the longest truss span yet completed on the American Continent. Gives interesting details in methods and operations of construction. 7500 w. Eng Rev—Jan. 3, 1903. No. 52907.

**Reinforced Concrete.**

See Civil Engineering, Construction.

**Suspension.**

The Damage to the New East River Bridge Cables by Fire and the Proposed Method of Repairing it. Technical portions of the report of the Board of Engineers appointed to report in regard to the repairs needed for the partially completed bridge across the East River at New York. 2200 w. Eng News—Jan. 22, 1903. No. 53170.

The Injury to the Cables of the New East River Bridge. Isaac Harry. Also report of commission appointed to report on the condition in which the fire left the cables of the new suspension bridge across the East River at New York. 1800 w. R R Gaz—Jan. 16, 1903. No. 53059.

**Viaduct.**

The Viaur Viaduct (Le Viaduct Métallique du Viaur). E. Godfernaux. An illustrated description of the steel railway viaduct over the Viaur Valley near Rodez in the south of France. The clear opening of the cantilevers is 220 metres. 6000 w. 2 plates. Rev Gen des Chem de Fer—Jan., 1903. No. 53230 H.

## CANALS, RIVERS & HARBORS.

**Canal Haulage.**

See Electrical Engineering, Power Applications.

**Cauvery Falls.**

See Elect. Engng., Generating Stations.

**Flood Warnings.**

The Flood Warning Service on the Danube and its Tributaries in Upper Austria (Vorschrift für den Hochwassernachrichten und Warnungsdienst fur die Donan und ihre Nebenflüsse in Oberoesterreich). With map showing the location of stations and very complete telegraphic connections. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst —Jan. 3, 1903. No.53261 D.

**Great Britain.**

Harbors and Waterways in 1902. A review of works under construction, and of matters relating to the harbors and waterways. 5500 w. Engr, Lond—Jan. 2, 1903. No. 52940 A.

**Irrigation.**

Irrigation. From Twelfth Census. An illustrated historical review of the irrigation work in America. 9500 w. Sci Am Sup—Jan. 10, 1903. Serial. 1st part. No. 52866.

Irrigation Works of India. Brief review of the extensive irrigating works which have cost the British Government over $150,000,000. 1100 w. U S Cons Repts, No. 1554—Jan. 26, 1903. No. 53128 D.

**Isthmian Canal.**

An Alternative Line for the Nicaragua Canal; and a Proposed New Method of Dam Construction. Discussion of a paper by J. Francis Le Baron. Map. 10,800 w. Pro Am Soc of Civ Engrs—Dec., 1902. No. 52632 E.

**Java.**

The Improvement of the Outlet of the Strait of Surabaya (Over den Toegang mit Zee naar Straat Soerabaja). J. W. Welcker. A discussion of the practicability of improving the channel from the strait of Madoera to the Java Sea, with a comparison with the mouth of the Rio Grande de Sal, and the Delta of the Nile. 3500 w. De Ingenieur—Dec. 20, 1902. No. 53248 D.

**Navigation.**

The International Navigation Congress at Düsseldorf, 1902 (Die Verhandlungen des IX Internationalen Schiffahrts-Kongresses in Düsseldorf, 1902). A. Schromm. Opening address, outlining in general the work of the congress. Two articles. 15,000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 2, 9, 1903. No. 53225 each B.

**New York Canals.**

Governor Odell on the Proposed 1000 Ton Barge Canal. A portion of the Governor's message to the legislature in regard to the project for the construction of a 1000-ton barge canal from Lake Erie to the Hudson river. 1300 w. Eng News—Jan. 15, 1903. No. 53054.

Proposed Improvements in the Erie Canal. Map, with review of the different plans for improvements proposed. 1200 w. Sci Am Sup—Jan. 17, 1903. No. 53048.

**Niagara.**

The Canadian Niagara Power Development. Orrin E. Dunlap. An illustrated account of construction work for the hydro-electric power plant on the Canadian side of Niagara Falls. 1800 w. Elec Rev, N Y—Jan. 3, 1903. No. 52849.

**Nile.**

The Opening of the Assouan Dam. An illustrated account of this recently completed work, with a review of the great engineering works of Egypt, the condition of the land, etc. 3300 w. Sci Am Sup—Jan. 10, 1903. No. 52865.

Nile Irrigation Works. W. Noble Twelvetrees. The present article is devoted to the Delta and the Delta barrage. Illustrated. Serial. Part I. 3500 w. Feilden's Mag—Jan., 1903. No. 53117 B.

**Review.**

Bridges, Foundations, Docks and Water Fronts, and Canals. William H. Burr. Reviews the work in this field during the last quarter of a century, the advances made, etc. 3000 w. Eng Rec—Jan. 3, 1903. No. 52912.

**Soulanges Canal.**

Electrical Work on the Soulanges Canal. Illustrates and describes the electrical installation which operates the sluices, gates and bridges of this new canal around the rapids of the St. Lawrence. 700 w. Engr, Lond—Jan. 9, 1903. No. 53031 A.

**Yazoo Delta.**

The Yazoo Delta of Mississippi and Location and Construction of Its Railroads. J. N. Darling. An illustrated description of the country and the methods of railroad construction. Discussion. Map. 4700 w. Jour W Soc of Engrs—Dec., 1902. No. 52660 D.

## CONSTRUCTION.

**Building Construction.**

Reduction of Fire Hazards in Building Construction. Perez M. Stewart and Rudolph P. Miller. Reviews the work in this field in the city of New York, presenting in detail the attitude of the Bureau of Buildings on many points of the building code, showing where improvements may be expected and the features of construction that tend to accomplish the desired results. 10,000 w. Ins Engng—Dec., 1902. No. 52627 C.

**Factories.**

Recent Practice in the Design, Construction and Operation of Raw Cane Sugar Factories in the Hawaiian Islands. J. N. S. Williams. An illustrated detailed description of works designed to meet the changed conditions and increase in production. 9700 w. Inst of Mech Engrs—Nov. 21, 1902. No. 52621 D.

**Fire-Escapes.**

Fire-Escapes in American Commercial Buildings. Charles A. Daubney. Considers points having a bearing on the safety of persons in case of fire, describing types of fire-escapes in use, and discussing their features. Gives suggestions for fire protection. Ill. 10300 w. Jour Roy Inst of Brit Archts—Dec. 6, 1902. No. 52616 F.

**Fireproofing.**

Testing Oven at the Underwriters'

Laboratories. Benjamin H. Glover. An illustrated description of an oven for testing various types of fire retardants used in these Chicago laboratories. 1200 w. Ins Engng—Dec., 1902. No. 52626 C.

**Reinforced Concrete.**

Ferro-Concrete Bridge Over the Sutton Drain, Hull. Brief illustrated description of the first bridge of this material built in England. 700 w. Engng—Jan. 2, 1903. No. 52937 A.

Loading Tests of a Reinforced Concrete Plate (Belastungsversuch an einer Armierten Betonplatte). Prof. Melan. A graphical examination of the stresses and strains in a plate of reinforced concrete, showing the importance of the proper location of the metallic reinforcement. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 19, 1902. No. 53221 B.

Reinforced Concrete (Der Eisenverstarkte Beton). W. Linse. The first installment of a general review of the subject, with data showing the increase in its use since 1892. Serial. Part I. 2000 w. Stahl u Eisen—Jan. 1, 1903. No. 53255 D.

Recent Experiments with Hennebique Beams at Lemberg (Neue Versuche mit Hennebiqueträgern in Lemberg). Dr. Max R. v. Thullie. Data and results of concrete beams reinforced with iron rods according to the Hennebique system. A mathematical analysis of the application of the results to future computation is appended. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 12, 1902. No. 53219 B.

Some Hints as to Reinforced Concrete Construction. Discusses the trustworthiness of this combination of steel and concrete so much used as a structural material. 1200 w. Jour Gas Lgt—Dec. 16, 1902. No. 52726 A.

The Concrete Bridge at Herkimer, N. Y., Over West Canada Creek, Now Being Constructed by the Utica & Mohawk Valley Railway Co. F. C. Phillips. Illustrated description of a viaduct for an electric railway, consisting of 10 reinforced concrete arches and 4 steel spans, 1212 feet long in all. 3500 w. St Ry Rev—Dec. 20, 1902. No. 53106 C.

The Cottancin System of Reinforced Construction. Brief description of this system of steel-cored brick and steel-cored cement construction which is largely employed in France. 900 w. Arch't, Lond—Dec. 19, 1902. No. 52611 A.

**Roofs.**

Progress in the Design of Roof Structures Since 1850. Ewing Matheson. A short history of the improvements during the last fifty years. Ill. 3000 w. Engr, Lond—Jan. 9, 1903. No. 53027 A.

**Sky-Scrapers.**

The Biography of an Office Building. Arthur Goodrich. An illustrated article tracing the development of the American sky-scraper from the signing of the contract to completion. 3200 w. World's Work—Jan., 1903. No. 52629 C.

**Spliced Joints.**

Spliced Joints in the Columns of Steel-Frame Buildings. John Stephen Sewell. A discussion of careless work on steel-framed buildings, and improvements needed. 2400 w. Eng News—Dec. 25, 1902. No. 52874.

**Structural Steel.**

Structural Steel Work in the Ansonia Apartment Hotel, New York—Roof Trusses, Tower and General Construction. Begins an illustrated detailed description of the steel work in this recently completed apartment hotel in New York, which is one of the largest and most costly yet built. 3300 w. Eng Rec—Jan. 10, 1903. Serial. 1st part. No. 52970.

**Tunnels.**

Tunnel Construction in Chicago. George W. Jackson. Illustrates and describes the method of driving and constructing adopted so as not to disturb the surface. 3600 w. Mines & Min—Jan., 1903. No. 52958 C.

**Underpinning.**

Underpinning the Philae Temples. A detailed accaunt of the work of underpinning these ancient temples in the Nile. Ill. 2400 w. Builder—Jan. 17, 1903. No. 53091 A.

## MATERIALS.

**Artificial Sandstone.**

The Manufacture and Properties of Artificial Sandstone. Samuel V. Peppel. Abstracted from the *Trans. of the Am. Ceramic Soc.*, 1902. Describes the material, processes of manufacture, quality, and the mechanical equipment needed. 5000 w. Eng News—Jan. 22, 1903. No. 53168.

**Cast-Iron.**

Experiences with Cast Iron Columns in Two English Spinning Mill Fires. Gives report of these fires which seem to indicate that the destruction of the buildings was due to the breaking of the cast-iron posts. 1000 w. Eng News—Jan. 1, 1903. No. 52881.

**Concrete.**

Pebble Faced Bridge in the National Park, Washington, D. C. W. J. Douglas. Illustrated description of a bridge designed for special surroundings, and of the methods of construction. 1100 w. Eng News—Jan. 22, 1902. No. 53167.

Strength of Concrete with Various Aggregates. Gives tables showing the strength of concrete made of various materials, with description of tests from which the results were derived. 1700 w. Munic Engng—Jan., 1903. No. 52649 C.

**Corrosion.**

Corrosion of the Steel Frames of Buildings. Charles L. Norton. An illustrated account of tests made and their results with conclusions drawn. 2000 w. Tech Quar—Dec., 1902. No. 52950 E.

**Explosives.**

A Safe and Economical Substitute for Dynamite. Reports the results of some tests made of Joveite. Also editorial on the safety powders destined to replace dynamite. 3300 w. Eng News—Jan. 22, 1903. No. 53169.

**Glass.**

Wire Glass (Le Verre Armé). Léon Appert. A complete description of the method of manufacturing plate glass with a wire netting imbedded in the mass. The product is valuable for strength, and resistance to fire. 10,000 w. 1 plate. Mem Soc Ing Civ de France—Oct., 1902. No. 53278 G.

**Reinforced Concrete.**

See Civil Engineering, Construction.

**Stone.**

Heat and Frost in the Weathering of Stone. George Barnum. An article discussing the effects of extremes of heat and cold and dissenting from views of Mr. Halbert Powers Gillette. 2000 w. Stone—Sept., 1902. No. 52640 C.

**Timber.**

Timber Preservation. Dr. von Shrenk. An informal general discussion mostly confined to the preservation of railway ties, the processes used and results, the kinds of wood, their decay and treatment. General discussion follows. Ill. 14300 w. Pro W Ry Club—Dec. 16, 1902. No. 52982 C.

## MEASUREMENT.

**Coast Survey.**

The U. S. Coast and Geodetic Survey. O. H. Tittmann. Reviews the history of this undertaking, the organization, work, etc. 3800 w. Nat Geog Mag—Jan., 1903. No. 52639 C.

**Geodesy.**

The Russo-Swedish Expedition for Measuring an Arc of the Meridian in Spitzbergen (Les Travaux de l'Expedition Russo-Suédoise pour la Mesure d'un Arc de Meridien au Spitzberg). A. Hansky. A fully illustrated account of the expedition. An arc of 4 degrees was measured up to 80 degrees north latitude. Two articles, 8000 w. Rev Gen des Sciences—Dec. 15, 30, 1902. No. 53250 each D.

**Photographic Surveying.**

Photographic Surveying. J. T. McIntyre. An illustrated discussion of this method of topographical surveying, and description of the instruments used. Serial. Part I. 5000 w. Feilden's Mag—Jan., 1903. No. 53114 B.

**Stereoscope.**

The Use of the Stereoscope in Topography and Astronomy (De l'Emploi du Stéreoscope en Topographie et en Astronomie). Col. Laussedat. A discussion of the use of stereoscopic photography in connection with surveying and astronomy with reference to recent topographic work in Austria. 2500 w. Comptes Rendus—Jan. 5, 1903. No. 53241 D.

**Surveying.**

Daylight Observation of Polaris to Establish a Meridian. W. O. Owens. Gives the writer's method of establishing his meridians in broad daylight. 2800 w. Eng & Min Jour—Jan. 10, 1903. No. 52969.

The Graphical Determination of Time Azimuth and Meridian (Ueber Graphische Bestimmung der Zeit, des Azimutes, und des Meridianes). E. Dolezal. Developing a graphical method of facilitating the computations, with diagrams for practical use. Serial. Part I. 1800 w. 2 plates. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 3, 1903. No. 53235 D.

## MUNICIPAL.

**City Work.**

City Engineering Problems. John M. Goodell. Reviews the improvements in surveying, paving, road construction, street clearing, etc. 2800 w. Eng Rec—Jan. 3, 1903. No. 52914.

**Fire Extinguishing.**

Fire Extinguishment in Chicago. William H. Musham. An account of the present organization of the fire department, its houses, apparatus, etc., showing that it has not kept pace with the growth of the city, and suggesting a revision of the building laws, compelling owners of high buildings to have a standpipe for each floor with proper connections. Ill. Discussion. 10300 w. Jour W Soc of Engrs —Dec., 1902. No. 52662 D.

Stationary Fire Pumps. George J. Jones. Describes a fire-fighting system recently installed in Philadelphia, the necessary water pressure being secured from a large stationary pumping plant. 1200 w. Sci Am—Jan. 24, 1903. No. 53077.

**Pavements.**

Employment of Belgian Sandstone for Paving. Discusses the value of this material, methods of testing, wearing qualities, etc. 3500 w. Quarry—Jan. 1, 1903. No. 52981 A.

**Sewage Purification.**

The Salford Sewage Works. J. Corbett. Abstract of a paper before the Sanitary Inst. Congress at Manchester, Eng. An account of some of the most interesting results of sewage purification experiments. 3000 w. Engng—Dec. 26, 1902. No. 52694 A.

The Septic Tank: Its Place in the Treatment of Sewage. Leonard P. Kinnicutt. Explains the result of septic action on sewage, and the effect when used with intermittent filtration beds, considering that in most cases it is a valuable adjunct. 1700 w. Eng Rec—Jan. 3, 1903. No. 52910.

The Septic Treatment of Sewage. Benjamin H. Flynn. Reviews the operation of this system, giving details of construction. 2800 w. Munic Jour & Engr—Jan., 1903. No. 52860 C.

**Sewerage.**

Sewerage Work; a Twenty-five Years' Review. Rudolph Hering. Reviews the works for collecting and conveying the foul waters and those for effecting their proper disposal, showing the rapid development in America. 2600 w. Eng Rec—Jan. 3, 1903. No. 52913.

The Separate System of Sewerage. J. Gust Richert, in *The Surveyor,* London. Describes some of the advantages, disadvantages and defects of this system which is considered more expensive but more efficient. 1400 w. Ill. Munic Jour & Engr—Jan, 1903. No. 52861 C.

**Sewers.**

The 64th St. Sewer Tunnel and Outlet Sewer, Brooklyn, N. Y. An illustrated description of this work and information relating to it. 3800 w. Eng News—Jan. 1, 1903. No. 52879.

## WATER SUPPLY.

**Charges.**

Apportionment of Charges for Private Fire Protection and the Means of Controlling the Supply Thereto. Report of committee and discussion. 17500 w. Jour N E Water Wks Assn—Dec., 1902. No. 52636 F.

**Filtration.**

The New Filtration Works in Philadelphia. J. A. Stewart. An illustrated description of the extensive works under construction, which will probably be the largest and most complete in the United States. 2000 w. Munic Engng—Jan., 1903. No. 52647 C.

The Philadelphia Filtration System. States the conditions at this city, giving an account of the early supply, and begins an illustrated description of the new system of filtration works. 2800 w. Eng Rec—Jan. 3, 1903. Serial. 1st part. No. 52921.

**Ground Water.**

An Artificial Underground Water Supply at Gothenburg, Sweden. Describes a unique method of developing a water supply, utilizing dangerous surface waters and a limited underground supply, and securing a naturally purified underground water. Describes the works. 2500 w. Eng News—Jan. 8, 1903. No. 52885.

**Ozone.**

German Ozone Waterworks. Dr. Ig. Erlwein. An illustrated description of water purifying works at Schierstein, near Wiesbaden and at Paderborn, Germany, where ozone is electrically produced from air and employed on a practical scale as a sterilizing and oxidizing agent. 1500 w. Elec Wld & Eng—Jan. 17, 1903. No. 52841.

The Sterilization of Water by Ozone upon the Siemens & Halske System. (Ueber die Abtötung Pathogener Bakterien im Wasser mittels Ozon nach dem System Siemens & Halske) Messrs. Schüder & Proskauer. A discussion of the experiments made upon the water of the river Spree, at Berlin. 2000 w. Gesundheits Ingenieur—Jan. 10, 1903. No. 53244 B.

Two German Plants for Sterilizing Water by Ozone. Illustrated description of the recently opened plants at Wiesbaden and Paderborn, which are the first German works using ozone for sterilizing drinking water on a commercial scale. 1000 w. Electro-Chem Ind—Jan., 1903. No. 53153 C.

**Pipe-Coatings.**

Coating of Cast-Iron Pipes. W. H. Humphreys. Reports great trouble due to contamination of water by the coating used, or its improper application. and gives opinions of manufacturers and discussion. 5800 w. Builder—Dec. 13, 1902. No. 52713 A.

**Pipe Specifications.**

Final Report of the Committee on Standard Specifications for Cast-Iron Pipe. Also discussion. 1600 w. Jour N. E. Water-Wks Assn—Dec., 1902. No. 52,-637 F.

**Pollution.**

The Detection and Prevention of Underground Pollution. John Shaw. Read before the British Assn. of Water-Wks. Engrs. Discusses the pollution of springs and well supplies. 2200 w. Builder—Dec. 27, 1902. No. 52714 A.

**Refrigeration.**

Water. E. T. Skinkle. On the proper handling of the water supply in the manufacture of ice and in cold storage. 2300 w. Ice & Refrig—Jan., 1903. No. 52606 C.

**Review.**

Twenty-five Years of Water Supply Engineering. J. J. R. Croes. Reviews the conditions at the two extremes of this period, showing the important advances made. 2700 w. Eng Rec—Jan. 3, 1903. No. 52911.

**Tank.**

Water Tank with Hemispherical Bottom at Washington Heights, Chicago. Brief illustrated description of a steel tank of interesting design having a capacity of 180,000 gallons. 900 w. Eng News—Dec. 25, 1902. No. 52873.

**Turbidimeter.**

A New Turbidimeter. Charles Anthony, Jr. Gives the methods usually employed in estimating turbidity, discussing each briefly, and explains a photometric method of measuring the amount of light absorbed by a given thickness of water; describing the instrument used. Discussion. 2800 w. Jour N. E. Water-Wks Assn—Dec, 1902. No. 52635 F.

**Waste.**

Report on Water Waste and the Metering of the Water Supply of Chicago. Made by John Ericson, City Engineer. 2500 w. Eng News—Jan. 8, 1903. No. 52887.

Water Waste and Its Detection. Edward S. Cole. Considers the sources of waste, the effect of meters, means of detecting waste, giving a brief description of the "Pitometer." Ill. Discussion. 8700 w. Jour W Soc of Engrs—Dec., 1902. No. 52661 D.

**Water-Softening.**

Water-Softening Plant at the Wilmslow (Stockport) Works. T. Molyneaux. Extracts from a paper read before the Brit. Assn. of Water-Wks. Engrs., with a summary of the discussion. Describes a plant which has a capacity of 25,000 gallons per hour, using the Archbutt-Deeley process. 3800 w. Jour Gas Lgt—Dec. 23, 1902. No. 52732 A.

### MISCELLANY.

**Excavation.**

Rock-Cutting Machines. An illustrated description of two recent examples of ingenious machines for breaking up rock under water, which have proved their value by executing an immense amount of subaqueous excavation. 800 w. Engng—Jan. 9, 1903. No. 52999 A.

**Review.**

Field Construction in Civil Engineering. Frank W. Skinner. Reviews what has been accomplished in the last quarter of a century in advance of previous practice. 3500 w. Eng Rec—Jan. 3, 1903. No. 52920.

1902. A general review of the year's progress in engineering,—civil, mechanical, electrical, sanitary, etc. 24000 w. Engr, Lond—Jan. 2, 1903. No. 52944 A.

# ELECTRICAL ENGINEERING

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### COMMUNICATION.

**Cables.**

Disturbances on Underground Cables. W. Schönau. A brief, illustrated account of disturbances on cables connecting the submarine cables terminating at Woosung, China, with Shanghai, and the improvement effected by an "induction balance" consisting of a condenser and resistance inserted between the circuits. 400 w. Elect'n, Lond—Dec.19, 1902. No. 52804 A.

Telephone Cables. Arthur V. Abbott, C. E. A discussion of the cost and maintenance of underground and aerial telephone cables, with diagrams. 1500 w. Elec Wld Engr—Jan. 3, 1903. No. 52826.

The Conditions Involved in Multiple Electric Conductors (Ueber die Definitionen der Elektrischen Eigenschaften von Mehrfach-Leitungssystemen). Dr. F. Breisig. A discussion of the conditions involved in using multiple conductor cables for telephone lines. 4500 w. Elektrotech Zeitschr—Dec. 25, 1902. No. 53265 B.

**Fire Alarms.**

The Transmission of Fire Alarms. E. B. Ellicott. An illustrated detailed description of the modern fire alarm system, especially as used in Chicago. Discussion. 8000 w. Jour W Soc of Engrs—Dec., 1902. No. 52663 D.

**Pacific Cable.**

Opening of the First Section of the Pacific Cable. An account of the opening of the section between San Francisco and Honolulu, with information concerning the depth, and other matters of interest. Ill. 900 w. Sci Am—Jan. 10, 1903. No. 52863.

**Space Telegraphy.**

Analysis of Wireless Telegraph Systems in 1902. A. Frederick Collins. An illustrated description and classification of the principal systems of wireless telegraphy. 3500 w. Elec Wld & Engr—Jan. 3, 1903. No. 52824.

A New Method of Tuning Spark-telegraphy Stations (Ueber ein Neues Verfahren zur Abstimmung Funkentelegraphischer Stationen). Count Arco. A discussion of the use of the multiplicator in connection with the Slaby-Arco system for maintaining selective communication.

6000 w. Elektrotech Zeitschr—Jan. 1, 1903. No. 53267 B.

Experiments on Selective Wireless Telegraphy. Anders Bull. Illustrated description of a system using a series of signals consisting of a fixed number of wave impulses, succeeding each other at pre-arranged short intervals of time. 2500 w. Elect'n, Lond—Jan. 2, 1903. No. 52808 A.

Record of the Year in Wireless Telegraphy. A. Frederick Collins. A review of the important events in space telegraphy in 1902. 1500 w. Elec Rev, N Y—Jan. 10, 1903. No. 53004.

The Braun-Siemens and Halske System of Wireless Telegraphy. Frank C. Perkins. An illustrated description of the apparatus used at the Cuxhaven station, on the North Sea. 900 w. Elec Engr, Lond—Jan. 2, 1903. No. 52822 A.

The Fessenden Wireless Telegraph System. A. Frederick Collins. Illustrates and describes the essential parts of this system. 1800 w. Sci Am—Jan. 3, 1903. No. 52771.

The Present State of Wireless Telegraphy. Maurice Solomon. A review of the subject with the object of forming an estimate of how far expectations have been fulfilled and what hopes may be entertained of a future of wide utility. Ill. 2500 w. Nature—Dec. 11, 1902. No. 52601 A.

Wireless Telegraphy (Drahtlose Telegraphie). Dr. Franke. A review of the present status of wireless telegraphy in Germany, with especial reference to the Braun system. 4500 w. Glasers Annalen —Jan. 15, 1903. No. 53229 D.

**Telegraph History.**

Old Time Telegraph History. A review of an interesting collection of original letters and documents relating to the early history of the telegraph, recently acquired by Cornell University. 4500 w. Elec Wld & Engr—Jan. 17, 1903. No. 52840.

**Telephone Central.**

The New Telephone Central in Düsseldorf (Das Neue Fernsprechvermittelungsamt in Düsseldorf). H. Kehr. With illustrations of wiring, switchboard and general arrangement. 2500 w. Elektrotech Zeitschr—Jan. 8, 1903. No. 53271 B.

**Telephone Lines.**

The Construction of Aerial Telephone Lines. Arthur V. Abbott, C. E. An illustrated discussion of pole lines for telephone circuits. Serial. Part I. 1200 w. Elec Wld & Engr—Jan. 17, 1903. No. 53119.

**Telephony.**

Port Arthur and Fort William Independent Telephone Systems. Illustrated detailed description of the equipment of these exchanges recently established in Canada. 1800 w. Can Engr—Jan., 1903. No. 52851.

The Evolution of the Modern Telephone System. L. A. Lindsey. An explanation of the systems at present in use, favoring the common battery, lamp signal, multiple system for large systems. 1600 w. Elec Wld & Engr—Jan. 24, 1903. No. 53164.

## DISTRIBUTION.

**Conduits.**

Conduit System of the Manhattan Railway. An illustrated description of the underground conduits and manholes for the electric cables of the high-tension distribution service of the New York elevated railways. 2200 w. St Ry Jour—Jan. 3, 1903. No. 53021 D.

**Converters.**

Behavior of Rotary Converters in Traction Installations with Stationary Accumulators. Dr. Angelo Banti. An account of the singular behavior which the converter displayed according to the kind of service to which it was devoted, and the conclusions. 2800 w. Elect'n, Lond—Jan. 16, 1903. No. 53099 A.

**Fuses.**

Safe and Accurate Electric Safety Fuses. Joseph Sachs. Considers their evolution, principle, operation, and application, describing devices and reporting tests. Ill. 5900 w. Jour Fr Inst—Jan., 1903. No. 52631 D.

**Static Converter.**

Cooper Hewitt Static Converter. An illustrated description, with curves, of an apparatus consisting of a globular vessel containing vapor, at a certain degree of attenuation, and several electrodes, which converts an alternating, or a polyphase current into a pulsating direct current. 1200 w. Elec Wld & Engr—Jan. 17, 1903. No. 52842.

**Substations.**

Substations of Manhattan Railway. A well-illustrated description of the construction, architecture and electrical equipment of the rotary converter substations for the elevated railway in New York. 5000 w. St Ry Jour—Jan. 3, 1903. No. 53020 D.

Also, Elec Wld & Engr—Jan. 3, 1903. No. 52832.

**Wiring.**

Direct Current Motor Wiring. P. C. Percy. General specifications for wires leading to direct-current motors, and full wiring tables; with diagrams. 900 w. Am Elect'n—Jan., 1903. No. 53015.

## ELECTRO-CHEMISTRY.

**Accumulator.**

A New Electric Accumulator. Dr. D. Tommasi. An illustrated description of a lead storage cell whose plates consist of a leaden frame containing a very large number of layers, and of an electrolyzer for the preparation of spongy lead. 600 w. Elec Rev, Lond—Jan. 2, 1903. No. 52817 A.

See also Electrical Engineering, Generating Stations.

See also Mechanical Engineering, Automobiles.

**Daniell Cell.**

Why the E. M. F. of the Daniell Cell Changes with the Density of the Solutions. Prof. Henry S. Carhart. A contribution to the author's studies on concentration cells. 1200 w. Electro-Chem Ind—Jan., 1903. No. 53152 C.

**Electric Furnaces.**

High-Temperature Electro-Chemistry. Notes on Experimental and Technical Electric Furnaces. R. S. Hutton and J. E. Petavel. Full paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Illustrated descriptions of experimental and technical electric furnaces and their commercial applications, especially some of the newer industries. 11200 w. Engng —Dec. 19, 1902. No. 52689 A.

The Electric Heat Furnace. A. Henrick Jackson. The first of a series of illustrated articles dealing with its industrial non-electrolytic uses. 2000 w. Aust Min Stand—Nov. 27, 1902. Serial. 1st part. No. 52739 B.

**Electrolyte Resistance.**

See Electrical Engineering, Measurement.

**Equivalents.**

Table of Electrochemical Equivalents and Their Derivations. Carl Hering. Probably the fullest table ever published. A complete recalculation based upon the most recent and best fundamental values. Applications of the table are illustrated by a series of typical examples. 6800 w. Electro-Chem Ind—Jan., 1903. No. 53150 C.

**Ozone.**

See Civil Engineering, Water Supply.

**Rectifier.**

The Electrolytic Rectifier. Prof. C. F. Burgess. Abstract of a paper presented before the Science Club of Wisconsin Univ., giving an account of investigations carried out in the Laboratory of Applied Electrochemistry, and the results obtained with a fused electrolyte. 2500 w. Wisconsin Engr—Dec., 1902. No. 53038 D.

**Refining.**

Electrolytic Refining of Gold. D. K. Tuttle. An illustrated description of the electrolytic gold refining process used in the United States Mint, in Philadelphia. Electro-Chem Ind—Jan., 1903. No. 53146 C.

**Review.**

Electrochemistry in the Year 1902 (Die Elektrochemie in Jahre 1902). Dr. M. Krüger. The annual review of the progress of applied electrochemistry in Europe and America. Serial, Part I. 2500 w. Elektrochem Zeitschr—Jan., 1903. No. 53274 G.

The Progress of Electro-Chemistry in 1902. George P. Scholl. A general review. 2500 w. Elec Wld & Engr—Jan. 3, 1903. No. 52828.

**Smelting.**

A French Plant for Making Steel in the Electric Furnace. An illustrated description of the Keller process used at Kerrousse. 2000 w. Electro-Chem Ind—Jan., 1903. No. 53148 C.

An Attempted Defence of the Electric Smelting of Iron Ores. Editorial criticizing statements made by A. J. Rossi in a paper published in the *Iron Age* of Nov. 20, 1902. 1000 w. Eng News—Jan. 8, 1903. No. 52886.

## ELECTRO-PHYSICS.

**Electro-Magnetism.**

Electro-Magnetic Rotations. Howard B. Dailey. Illustrates and describes experiments showing the rotational features of electro-magnetism. 1300 w. Sci Am—Dec. 27, 1902. No. 52765.

**Electrons.**

Faraday's Law and the Theory of Electrons. Letter from Dr. H. C. Cooper. 600 w. Electro-Chem Ind—Jan., 1903. No. 53154 C.

**Theories.**

Electrical Theories. Dr. John Trowbridge. A review of present theories of electrical and magnetic phenomena. 800 w. Elec Rev, N Y—Jan. 10, 1903. No. 53000.

## GENERATING STATIONS.

**Accumulators.**

Storage Batteries in Electrical Supply. Alton D. Adams. Data concerning the operation of storage batteries in a large system of electrical supply during a period of more than three years. Tables. 1200 w. Elec Wld & Engr—Dec. 27, 1902. No. 52843.

**Armature Discs.**

The Construction of Slotted Armature Discs (Ueber die Herstellung Genutheter Ankerblechscheiben). R. Hundhausen. Illustrated description of the special tools used by Siemens & Halske at Charlottenburg. Two articles, 4000 w. Elektrotech Zeitschr—Dec. 18, 25, 1902. No. 53264 each B.

**Bournemouth.**

The Bournemouth Corporation Tramways. An illustrated description of a combined conduit and overhead trolley electric railway at Bournemouth, England. 2500 w. Elect'n, Lond—Jan. 9, 1903. No. 53120 A.

**Brussels.**

St. Gilles Electric Power and Luttiches Street Railway. Frank C. Perkins. An illustrated description of an electric power station near Brussels, Belgium, operated in connection with the Liége railway. 1000 w. Elec Rev, N Y—Dec. 27, 1902. No. 52846.

**Burlington, Vt.**

Water Power on the Winooski. Alton D. Adams. Illustration, with description of the station in which electric power is generated for the city of Burlington, Vt. 1200 w. Elec Wld & Engr—Jan. 24, 1903. No. 53162.

**Cauvery Falls.**

Electric Power in India. The Cauvery Falls Plant. Capt. J. H. Thomson. A well illustrated account of a great hydro-electric plant in the State of Mysore, from which energy is transmitted 92 miles to the Kolar Gold Mines. 4500 w. Cassier's Mag—Jan., 1903. No. 52800 B.

**Condenser Excitation.**

Excitation of Asynchronous Generators by Means of Static Condensance. A. S. McAllister. A description, with diagram, of a method of using a condenser as a source of exciting current for an asynchronous generator. 1600 w. Elec Wld & Engr—Jan. 17, 1903. No. 52838.

**Costs.**

Electricity Supply Works Costs in 1900 and 1901. Tables and curves, with explanatory text, which summarize data obtained by analyses of the accounts of electric stations, both municipal and company, in the United Kingdom. 2000 w. Elect'n, Lond—Jan. 2, 1903. No. 52810 A.

**Dynamo Designing.**

A Criticism of Present-Day Continuous-Current Designing. Fred W. Davies. A discussion of various points in the design of continuous-current dynamos and motors. 2500 w. Elec Rev, Lond—Dec. 19, 1902. No. 52812 A.

Rotating Ring with Attached Lugs. Forrest R. Jones. Considers the design of rings of electric generators with regard to tension in ring and lug bolts. 1800 w. Mach, N Y—Jan., 1903. No. 52859.

Stress on Frames of Alternating Current Generators. P. J. Frenell. Deals with the question of mechanical design for the purpose of reducing unnecessary weight and cost in the construction of large machines. 1600 w. Elec Wld & Engr—Jan. 24, 1903. No. 53163.

The Designing of Polyphase-Current Machines. David Bergman. A discussion, with curves, of various points in the design of polyphase motors and generators. 1200 w. Elec Rev, Lond—Dec. 26, 1902. No. 52813 A.

**Erith.**

Erith Electricity Works. An illustrated description of works employing the four-wire three-phase system of distribution. 2000 w. Elect'n, Lond—Jan. 16, 1903. No. 53098 A.

**Galveston.**

New Lighting and Power Plant of the Galveston City Railway Co. An illustrated description of an electric station for railway, lighting and power service, built to replace one destroyed in the great storm of September, 1900. 3000 w. St. Ry Rev—Dec. 20, 1902. No. 53102 C.

**Garvin's Falls.**

The Garvin's Falls Station of the Manchester Traction, Light and Power Company. W. V. Batson. Illustrated description of one of the largest hydro-electric power systems in New England. 2700 w. Eng Rec—Jan. 24, 1903. No. 53157.

**Hastings.**

Electricity Supply in Hastings. An illustrated description of an electric station at Hastings, England, and an account of experiments made with the Andrews "discriminating" transformer and choking coil and with other apparatus. 5000 w. Elec Rev, Lond—Dec. 26, 1902. No. 52814 A.

Some Experiments at the Hastings Electricity Works. An illustrated account of short-circuiting experiments showing the action of the Andrews "discriminating" transformer and choking coil, and of other experiments showing various apparatus and arrangements at Hastings, England. 3200 w. Elect'n, Lond—Dec. 26, 1902. No. 52806 A.

**Hochfelden-Oerlikon.**

See Electrical Engineering, Transmission.

**Leeds.**

Leeds Electric Power Station. An illustrated description of a 9,000-kilowatt electric station at Leeds, England. 1000 w. Elec Rev, N Y—Jan. 3, 1903. No. 52848.

**Legislation.**

Swiss Laws Regulating Electric Installations (Schweizerisches Bundesgesetz betreffend die Elektrischen Schwach und Starkstromanlagen). The full text of the recent enactments of June, 1902, regulating both moderate and heavy currents. 4000 w. Elektrotech Zeitschr—Jan. 1, 1903. No. 53268 B.

**Liquid Fuel.**

See Mechanical Engineering, Steam Engineering.

**London.**

The Electricity Works of the Central Electric Supply Company. An illustrated description of a London central station generating three-phase currents at 6000 volts. 1200 w. Elect'n, Lond—Jan. 9, 1903. No. 53121 A.

**Maidenhead.**

Maidenhead Electricity Supply Works. An illustrated general description of a continuous-current, three-wire system lately installed at the municipal works of Maidenhead, England, near the Thames. 4000 w. Elec Engr, Lond—Dec. 19, 1902. No. 52819 A.

**Middlesbrough.**

300-Kilowatt Triple-Expansion Engine; Middlesbrough Electricity Works. Illustrated description of a direct-driven electric generating plant. 1200 w. Engng—Dec. 26, 1902. No. 52693 A.

**Modern Practice.**

Modern Tendencies in the Development and Transmission of Power. John Joseph Flather. Slightly condensed from an address at the Washington meeting of the Am. Assn. for the Adv. of Science. Discusses useless waste of power, electric power distribution in shops, speed variation with electric motors, efficiency of electric power transmission, power development with gas engines, steam turbines, etc. 4500 w. Eng News—Jan. 1, 1903. No. 52878.

**Motive Power.**

Steam Engine vs. Internal Combustion Engine for Electric Power Generating Plants. Frank C. Perkins. An illustrated article giving information in regard to recently erected plants where gas engines have been installed and the systems used, the Diesel oil engines, and others. 5800 w. Mod Mach—Jan., 1903. No. 52603.

**New York.**

The Waterside Electric Station (Station Centrale Electrique de Waterside). F. Drouin. An illustrated description of the Waterside station of the New York Edison Company with comments from a French point of view. 3000 w. 1 plate. Génie Civil—Dec. 13, 1902. No. 53205 D.

**Niagara**

The New Hydraulic Plant at Niagara (La Nouvelle Usine Hydro-Electrique des Chutes du Niagara). Description of the new works, with illustrations of the wheels, shaft, regulators and switchboards. 2000 w. 1 plate. Génie Civil—Jan. 3, 1903. No. 53213 D.

The New Niagara. Waldon Fawcett. Brief illustrated account of the several power plants for the development of electrical energy. 1300 w. Am Mfr—Dec. 25, 1902. No. 52746.

See also Civil Engineering, Canals, Rivers and Harbors.

**Parallel Working.**

The Influence of the Governor Upon the Parallel Working of Alternators (Influence des Regulateurs sur le Fonctionnement en Parallelle des Alternateurs). M. de Marchena. A discussion of the speed regulation of engines for driving alternators in parallel, with regard to the angular variations in velocity. 15,000 w. Bull Soc Int des Electriciens—Nov., 1902. No. 53260 H.

**Pike's Peak.**

The Water and Electric Power System of the Pike's Peak Power Co., Colorado. W. P. Hardesty. Illustrated detailed description of the development of this system, which is the first large enterprise to utilize the streams of Pike's Peak. 5000 w. Eng News—Jan. 1, 1903. No. 52877.

**Portland.**

See Electrical Engineering, Transmission.

**Prudential Buildings.**

A Large and Modern Isolated Power Plant. A well-illustrated description of the steam and electrical plant and equipment of the buildings of the Prudential Insurance Co., Newark, N. J. 4000 w. Am Elect'n—Jan., 1903. No. 53010.

**Review.**

Central Station Progress During 1902. W. S. Barstow. A general review of electric generating station practice. 1800 w. Elec Wld & Engr—Jan. 3, 1903. No. 52829.

**Rotwein.**

The Rotwein Electric Plant (Das Elektrizitatswerk in der Rotweinklamm). A description of the manner in which a mountain torrent was used to develop 850 h. p. for use in cutting the Karawanken tunnel near Assling, in Carinthia. 1500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 3, 1903. No. 53262 D.

**St. Georges.**

The Distribution of Electric Energy in the Department of Aube (Distribution de l'Energie Electrique dans le Départment de l'Aube). An illustrated description of the hydro-electric station at St. Georges, department of Aube, France, developing 3,200 horse power, and distributing current for a radius of 30 kilometres. Two articles, 2000 w. L'Electricien—Jan. 3, 10, 1903. No. 53283 each B.

**Sault Ste. Marie.**

Sault Ste. Marie and Its Industries.

Brief account of the developments on the Canadian and United States sides of the St. Mary's river. Ill. 4700 w. Can Eng—Jan., 1903. No. 52852.

**Short Circuits.**

Armature Reactions in Short Circuiting Polyphase Generators (Ankerreactie en Kortsluiting van Draaistromgeneratoren). A. C. van Rossem. An analytical and graphical treatment of the effects of short circuiting, discussing the methods of Behn-Eschenburg, Rothert, and Potier. 2000 w. De Ingenieur—Jan. 3, 1903. No. 53249 D.

**Station Design.**

Some Engineering Hints on a Tramway System. W. Dalton. A discussion of some of the chief points in the design and running of an electric railway power station, cables, electrolysis, etc. 2800 w. Elec Engr, Lond—Dec. 19, 1902. No. 52-820 A.

**Statistics.**

Connections to Electricity Supply Works. Deductions from the large table of electric station statistics in the United Kingdom, published as a supplement, with diagrams showing the growth of business in both London and the Provinces. 600 w. Elect'n, Lond—Jan. 9, 1903. No. 53122 A.

Statistics of Electric Stations in Germany (Statistik der Elektrizitätswerke in Deutschland). The usual annual statement of the electric generating stations in Germany, with comparisons with preceding years. Also editorial. 15000 w. Elektrotech Zeitschr—Dec. 18, 1902. No. 53-263 B.

**Transformers.**

See Electrical Engineering, Measurement.

## LIGHTING.

**Arc Lamps.**

Light and Illumination. E. Leavenworth Elliott. Reviews the history and development of the arc lamp. 3800 w. Cent Sta —Jan., 1903. No. 52963.

**Costs.**

The Cost of Electric Light and Electric Light Plants to Municipalities. Comparison of data from reliable sources, particularly with reference to cities of about 50,000 population. 2000 w. Munic Engng—Jan., 1903. No. 52648 C.

**Incandescent Lamps.**

The Manufacture of Incandescent Lamps (Fabrication des Lampes Electriques à Incandescence). Paul Razous. A general account of the manufacture of incandescent glow lamps, including the preparation of the filament and the exhausting of the bulbs. 2000 w. Génie Civil—Dec. 20, 1902. No. 53209 D.

**Interior Lighting.**

Electric-Lighting Arrangements in Flats, Offices and Residences. F. J. Warden Stevens. Suggestions for the economical lighting of residential flats, offices and like buildings. 2300 w. Archt, Lond —Jan. 2, 1903. No. 52928 A.

**Photometry.**

See Electrical Engineering, Measurement.

**Recent Progress.**

Recent Lighting Progress. Henry Noel Potter. A review of the Bremer arc lamp, Cooper Hewitt vapor lamp, osmium lamp, Nernst lamp and general electric lighting progress. 2200 w. Elec Rev, N Y—Jan. 10, 1903. No. 53003.

## MEASUREMENT

**Dynamometer.**

The Electromagnetic Absorption Dynamometer. C. Arthur Conant, and Clifton R. Hayes. Illustrated description of a novel piece of apparatus in the Electrical Laboratory of the Worcester Polytechnic Inst. 3200 w. Jour Worcester Polytechnic —Jan., 1903. No. 53133 C.

**Electrolyte Resistance.**

Observations on the Ohmic Resistance of Electrolytes and Its Determination. J. Wright. An illustrated discussion of the difficulties of measuring the resistance of electrolytes and of various methods for doing so. 2000 w. Elec Rev, Lond—Jan. 2, 1903. No. 52815 A.

**Electrometer.**

A New Capillary Electrometer. George J. Burch, F. R. S. Abstract of a paper before the Royal Society, with illustrated description of an electrical measuring instrument for laboratory use, and of the method of putting in the capillary tubes. 1000 w. Elect'n, Lond—Dec. 19, 1902. No. 52805 A.

**Fault Localising.**

Fault Localising on Tramway Systems. A. Johnston. An illustrated description of a method of localising faults on overhead wires, conduits and feeders of electric railway systems. 1200 w. Elec Rev, Lond—Jan. 9, 1903. No. 53123 A.

**Impedance.**

The Relation of Synchronous Inpedance to the Impedance at Standstill. F. Townsend, H. P. Freund, W. I. Reich. An account, with diagrams, of experiments on the impedance of several alternating-current generators. 1000 w. Elec Wld & Engr—Jan. 3, 1903. No. 52825.

**Insulation Resistance.**

Reducing the Measured D. R. of a Laid Submarine Cable to 75° F. and Atmospheric Pressure. J. Rymer-Jones. A discussion, with formulæ, showing that to get the true insulation resistance, a submarine cable must be considered in sections in which the conditions are uniform. 2000 w. Elec Rev, Lond—Jan. 2, 1903. No. 52818 A.

**Magnetic Measurements.**

Industrial Magnetic Measurements (Sur les Mesures Magnétiques Industrielles). M. Armagnat. A discussion of practical methods of determining the magnetic properties of iron in connection with the commercial manufacture of apparatus. 1200 w. Bull Soc Int des Electriciens—Nov., 1902. No. 53259 H.

**Motor Diagrams.**

A Graphical Discussion of the Cascade Operation of Polyphase Motors (Graphische Behandlung der Kaskadenschaltung von Drehstrommotoren). Dr. Max Bresslauer. An application of Heyland's graphical method to the analysis of the operation of motors in cascade. 5000 w. Elektrotech Zeitschr—Jan. 1, 1903. No. 53266 B.

Graphical Determination of Speed, Current, and Motor-Load from the Motor Diagram (Graphische Ermittelung von Geschwindigkeit, Stromverbrauch und Motorbelastung Elektrischer Fahrzeuge aus dem Motordiagramm). R. Mauermann. A description of the use of power, current, and velocity curves in proportioning a projected electric tramway installation. 3000 w. Elektrotech Zeitschr—Jan. 8, 1903. No. 53270 B.

Polar Diagrams of Induction Motors (Kreisdiagramm des Drehstrommotors). J. K. Sumec. An application of the polar diagram to the determination of iron losses, capacity, slip, and efficiency of induction motors. 2000 w. Zeitschr f Elektrotechnik—Jan. 4, 1903. No. 53276 D.

Three-Phase Measurements. Leslie L. Perry. Description, with diagrams, of a method for measuring the power factor of any three-phase circuit, no matter how unbalanced are the currents and voltages. 600 w. Elec Wld & Engr—Jan. 10, 1903. No. 52835.

**Photometry.**

Photometry for Electricians—and Others. An abstract of a paper by Dr. J. A. Fleming before the Inst. of Elec. Engrs. and of the discussion that followed. 4000 w. Jour Gas Lgt—Dec. 16, 1902. No. 52-728 A.

The Photometry of Electric Lamps. Dr. J. A. Fleming. Abstract of a paper before the Institution of Electrical Engineers, considering standards; processes of measurement; heterochromic photometry; and international agreements. Illustrated. Serial. Part I. 5500 w. Elect'n, Lond—Jan. 2, 1903. No. 52811 A.

**Potential.**

The Determination of Differences of Potential with the Telephone as a Zero Instrument (Die Messung von Potentialdifferenzen mittels Telephon als Messinstrument). Franz Fischer. A description of the application of the telephone to the compensation method of measuring differences of electric potential. 2000 w. Zeitschr f Elektrochemie—Jan. 1, 1903. No. 53275 G.

**Quantometer.**

An Electric Quantometer. R. Beattie. An illustrated description of an instrument for magnetic measurements, particularly the measurement of magnetic fluxes in dynamos. A sort of "summation" ballistic galvanometer. 2500 w. Elect'n, Lond—Dec. 26, 1902. No. 52807 A.

**Transformers.**

Graphical Examination of Current and Pressure in Transformers (Graphische Methode zur Ermittelung des Strom und Spannungswerte von Ungleichmassigbelasteten Drehstromtransformatoren). Aug. König. An application of the graphical method of Blanc, using the vector analysis. 6000 w. Elektrotech Zeitschr—Jan. 8, 1903. No. 53269 B.

**Vector Analysis.**

Phase Difference and Vector Summation. George T. Hanchett. An explanation of the application of victor analysis to alternating-current calculations. Ill. 1200 w. Cent Sta—Jan., 1903. No. 52964.

## POWER APPLICATIONS.

**American Motors.**

American Practice in Electric Motor Construction. A very fully illustrated description of many makes of electric motors, both direct and alternating current, and their parts. 10000 w. Am Elect'n—Jan., 1903. No. 53012.

**Canal Haulage.**

Electrical Haulage on Canals. E. W. Marchant, D. Sc. Paper before the Manchester Section of the Institution of Electrical Engineers, illustrating and describing various systems of electric traction for canals. Serial. Part I. 2000 w. Elect'n, Lond—Jan. 2, 1903. No. 52809 A.

**Centrifugal Machines.**

An Electrically-Driven Centrifugal Machine. Illustrates and describes two different patterns of a new centrifugal machine of British make. 800 w. Engng—Dec. 19, 1902. No. 52685 A.

**Elevators.**

Electric Elevators. An illustrated review of the principal types used in Paris. Translated from *La Nature*. 2500 w. Sci Am Sup—Dec. 27, 1902. No. 52768.

**Furnace Plant.**

Electric Power for Blast Furnaces and Coke Ovens (Emploi de l'Electricité pour le Service des Fours à Coke et des Hauts Fourneaux). J. Bratman. Describing the electric handling machinery at Newport, near Middlesbrough, England. 2000 w. Génie Civil—Jan. 3, 1903. No. 53212 D.

**Induction Motors.**

Determination of Induction Motor Characteristic Curves. A. S. M'Allister. Mathematical discussion of induction motors, with formulæ, diagrams and tables. 2500 w. Am Elect'n—Jan., 1903. No. 53011.

Oerlikon Induction Motor with Four Speed Variations. Hans Behr. Description, with illustrations and diagrams, of a drum-wound induction motor, with its switches and connections. 2000 w. Elec Wld & Engr—Jan. 17, 1903. No. 52839.

**Machine Driving.**

Continuous Current Motors for Machine Tools. F. O. Blackwell. A description of the characteristics of the different classes of metal working tools, of the requirements of motors for operating them, of the conditions limiting the range of speed variation, and some of the methods of obtaining it with continuous current motors. 1800 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52657 D.

Electrical Distribution in the Machine Shop in 1903. Kern Dodge. A brief discussion of the application of electric motors to driving machine tools. 1200 w. Elec Wld & Engr—Jan. 3, 1903. No. 52831.

Electrical Distribution of Power in Industrial Establishments. Cecil P. Poole. The last twenty-five years really covers the history of the use of motors in factories, mills, etc. The methods are discussed. 2000 w. Eng Rec—Jan. 3, 1903. No. 52918.

The Operation of Machine Shops by Individual Electric Motors. R. T. E. Lozier. Data concerning the load factor and operation of machine shops, and a description of the advantages derived from the use of individual electric motors. Ill. 4000 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52651 D.

The Requirements of Machine Tool Operation with Special Reference to the Motor Drive. Charles Day. Extracts from a paper read before the N. Y. Elec. Soc. Considers the method of driving, the requirements to be met, the factors to be considered, and the importance of management and organization to obtain the result desired. 4000 w. Ir Age—Jan. 8, 1903. No. 52675.

Also Elec Wld & Engr—Jan. 10, 1903. No. 52836.

**Mining.**

Electrical Mining Notes. Sydney F. Walker. An account of instance in English coal mining operations where electrical apparatus saved money. 1500 w. Elec Rev, N. Y—Jan. 3, 1903. No. 52847.

**Motor Diagrams.**

See Electrical Engng., Measurement.

**Ore Dressing.**

See Mining and Metallurgy, Mining.

**Polyphase Designing.**

See Electrical Engineering, Generating Stations.

**Pumping.**

Economic Operation of Electric Irrigation Pumps. Aug. J. Bowie, Jr. A discussion of electric pumping stations for irrigation systems, and of irrigation systems in general. 3500 w. Elec Wld & Engr—Dec. 27, 1902. No. 52844.

Electric Pumping Plant (Installations Electriques d'Epuisement). J. Loubat. Describing the pumping plant of the Monterrad shaft of the Roche-la-Molière and Firming Company, with illustrations of the surface electric plant and the subterranean pumps. 2000 w. Revue Technique—Dec. 25, 1902. No. 53215 D.

**Sale.**

The Sale of Power. Robert S. Hale. Discusses questions involved in the sale of power from small plants. 3800 w. Engr, U S A—Jan. 15, 1903. No. 53140.

**Series Alternating.**

The Series Alternating Motor Problem. George T. Hanchett. An explanation, with diagrams, of the difficulties of operating single-phase alternating current railway motors, and the way these difficulties have been met. 2500 w. St Ry Jour—Dec. 20, 1902. No. 53017 D.

**Shipyard.**

The Electrical Equipment of a Modern Shipyard. An illustrated description of the electrical generating and driving equipment of the plant of the New York Shipbuilding Co., at Camden, N. J. 2200 w. Elec Rev, N Y—Jan. 17, 1903. No. 53009.

**Speed Control.**

A Series-Parallel System of Speed Control. George W. Fowler. A description of the parts of a system including a double commutator motor, switchboard controller, automatic switches and emergency switches. Ill. 1500 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52655 D.

Discussion of Papers on Speed Control of Electric Motors. 5800 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52658 D.

Electrically Operated Coal Hoist Having Variable Speed Control. P. O. Keilholtz. Illustrated description and data concerning the operation. 500 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52654 D.

Multiple Unit, Voltage Speed Control for Trunk Line Service. H. Ward Leonard. A description of a single phase, high tension, alternating current system for operating trunk line railways. Conversion takes place on each locomotive and substations are eliminated. Ill. 1200 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52656 D.

The Storage Battery as a Factor in Speed Control. H. B. Coho. A description of the use of storage batteries in connection with the operation of printing presses and with the multiple voltage system. 800 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52653 D.

Three-Wire System for Variable Speed Motor Work. N. W. Storer. A description of the operation of variable speed d. c. motors on the three-wire system. Ill. 2500 w. Trans Am Inst of Elec Engrs—Dec., 1902. No. 52652 D.

Variable Speed Motor Control. Charles F. Scott. Introductory address at a meeting where most of the papers were on this subject. 1300 w. Trans Am Inst. of Elec Engrs—Dec., 1902. No. 52650 D.

**Steel Works.**

Electrical Equipment of the Antwerp Steel Works. An illustrated description of these large iron and steel works, which will require 30,000 horse power to operate them, electric motor driving being employed throughout. 1600 w. Feilden's Mag—Jan., 1903. No. 53115 B.

**Sugar Factory.**

Electric Power Transmission in a Cube Sugar Factory. An illustrated description of the application of electric driving in a cube sugar factory in Bohemia. 1800 w. Elec Rev, Lond—Jan. 9, 1903. No. 53124 A.

## TRANSMISSION.

**High Voltage.**

Evolution in High-Voltage Transmission. Charles F. Scott. A general sketch of the advance that has been made to present practice. 1600 w. Elec Rev, N Y—Jan. 10, 1903. No. 53002.

**Hochfelden-Oerlikon.**

The First Three-Phase Power Transmission Plant in Europe Operating at 30,000 Volts. Dr. H. Behn-Eschenburg. A well-illustrated description of power house and transmission line, and experience in operation of the power transmission from Hochfelden to Oerlikon, Switzerland. 5000 w. Elec Wld & Engr—Jan. 3, 1903. No. 52823.

**Manchester, N. H.**

See Electrical Engineering, Generating Stations.

**Pole Lines.**

Pole Lines for Power Transmission. Alton D. Adams. A description of the poles and wires of some of the principal long-distance, high-tension electric transmission lines in the United States. Serial, 2 parts. 4000 w. Elec Rev, N Y—Jan. 10 and 17, 1903. No. 53006.

**Portland.**

Electrical Supply from Water Power at Portland, Me. Alton D. Adams. Illustrated description of a hydro-electric plant at Great Falls, on the Presumpscot River, the outlet of Sebago Lake, Maine, and the transmission line to Portland. 2400 w. Elec Wld & Engr—Jan. 10, 1903. No. 52833.

**Potential Variations.**

The Variation of Potential Along a Wire Transmitting Electric Waves. C. A. Chant. Reviews briefly experiments made by investigators of these "wire-waves," giving description of recent experiments made and their results. Ill. 4000 w. Am Jour of Science—Jan., 1903. No. 52638 D.

**Resonance.**

Resonance Phenomena in Long Distance Transmission (Resonanzerscheinungen in Fernleitungen). W. Blanck. A mathematical investigation of the relations between resonance and length of line in power transmissions. 1000 w. Zeitschr f Elektrotechnik—Jan. 4, 1903. No. 53277 D.

## MISCELLANY.

**Electrical Advances.**

The Relation of Electrical and Civil Engineering. Thomas Commerford Martin. Indicates some of the relationships that have developed during the last quarter of a century, the advances made, etc. 2800 w. Eng Rec—Jan. 3, 1903. No. 52-919.

**Europe.**

A Review of Electrical Engineering in Europe During 1902. A. Webster. A general review. 3500 w. Elec Rev, N Y—Jan. 10, 1903. No. 53007.

**Railway Signaling.**

See Railway Engineering, Permanent Way.

**Review.**

The Progress of Electrical Science During the Year 1902. A. E. Kennelly. A general review. 2200 w. Elec Wld & Engr—Jan. 3, 1903. No. 52827.

# GAS WORKS ENGINEERING

**Acetylene.**

Purification of Acetylene. Abstract of articles by Herr G. Keppeler published in *Journal für Gasbeleuchtung.* Investigations of the value of purifying materials. Heratol is said to be the most perfect in its action. 1800 w. Jour Gas Lgt—Dec. 30, 1902. No. 52934 A.

**Alcohol.**

Lighting by Alcohol. Abstract of a communication presented by M. Arachequesne at a meeting of the Sociéte des Ingénieurs Civils de France. Gives illustrated descriptions of appliances for burning alcohol, and the conclusions. 2000 w. Jour Gas Lgt—Jan. 13, 1903. No. 53096 A.

**Burners.**

Care and Maintenance of Incandescent Gas Burners. McDougald Dexter. Showing that these burners need expert attention, and urging the gas companies to assume their adjustment and maintenance. 2500 w. Gas Engrs' Mag—Dec. 10, 1902. No. 52617 A.

**Charging.**

A Combined Charging and Drawing Machine. An illustrated description of an improved machine, invented by John West, for economy in retort-house labor. 4800 w. Jour Gas Lgt—Dec. 16, 1902. No. 52727 A.

**Cyanide.**

The Gas Industry and the Manufacture of Cyanide. An abstract translation of an article by M. M. Robnie and Leuglen in the *Revue Générale de Chimie Pure et Appliquée.* Deals with the extraction of cyanides as bye-products in the manufacture of gas. 2500 w. Jour Gas Lgt—Jan. 6, 1903. No. 52991 A.

**Factories.**

The Lighting of Factories. J. H. Brearley. Read before the Manchester Dist. Assn. of Gas Engrs. Aims to show that not only can gas lighting maintain its ground in this field, but there is reason to hope that it may regain some of the ground lost. 4400 w. Jour Gas Lgt—Dec. 9, 1902. No. 52723 A.

**Gas-Fires.**

The Choice of Gas Fires. Thomas Fletcher. Defending gas fires and stating some of their advantages. 900 w. Jour Gas Lgt—Dec. 23, 1902. No. 52730 A.

**Gas Power.**

See Mechanical Engineering, Special Motors.

**Gas Works.**

New Gas-Works at Blackpool. Brief illustrated description of works erected to meet the increased demand for gas. 1200 w. Jour Gas Lgt—Dec. 23, 1902. No. 52731 A.

The Granton Works of the Edinburgh and Leith Gas Commissioners. Walter Ralph Herring. An illustrated description with two plates, one showing the method of surveying the site and giving several sections, the other giving a plan of the works so far as they at present exist with future sections outlined, and the drainage system. 3800 w. Jour Gas Lgt—Jan. 6, 1903. No. 52989 A.

**Illuminants.**

The future of Coal Gas and Allied Illuminants. Prof. Vivian B. Lewis. The first of a series of lectures showing the changes in conditons during the last twenty years, and the direction in which they tend. 7000 w. Jour Soc of Arts—Dec. 26, 1902. Serial. 1st part. No. 52600 A.

**Incandescence.**

Experiences of Incandescent Street Lighting at Formby. J. H. Buckley. Read before the Manchester Dist. Inst. of Gas Engrs. An explanation of the methods adopted and the causes of the high average of renewals, with the writer's opinion of what is required to make incandescent street-lighting a success. 1400 w. Jour Gas Lgt—Dec. 9, 1902. No. 52724 A.

Some Notes on Several Types of Mantles for Incandescent Gas Burners. William Lincoln Smith. An account of a series of tests made upon a number of styles of mantels to determine their characteristics. 4000 w. Tech Quar—Dec., 1902. No. 52951 E.

**Inclined Retorts.**

An English Inclined Retort Installation in Italy. Illustrates and describes a large installation lately completed at the Milan Gas Works, with an account of the work of construction and information of interest. 3400 w. Jour Gas Lgt—Jan. 13, 1903. No. 53095 A.

An Inclined Retort-House and Its Working at Bristol. An illustrated description of a recently installed plant where the working is as completely mechanical as possible, giving costs and information of interest. 4300 w. Jour Gas Lgt—Jan. 6, 1903. No. 52990 A.

**Lamps.**

The Lucas Lamps. Summary of a paper

by Dr. H. Lux, published in the *Zeitschrift für Beleuchtungswesen.* Briefly describes this lamp, which aims to get the fullest amount of light from gas, without the aid of extraneous appliances. Describes tests and gives conclusions. 1000 w. Gas Wld—Dec. 27, 1902. No. 52736 A.

**Natural Gas.**

Kansas Natural Gas ,Its Control and Distribution. Prof. W. R. Crane. Illutrated description of the method employed in burning it and in measuring the pressures. 4400 w. Mines & Min—Jan., 1903. No. 52957 C.

Natural Gas in England. From the *Statist.* Report of a visit to Heathfield and a discussion of the possibilities of English natural gas. 2500 w. Gas Engrs' Mag—Dec. 10, 1902. No. 52618 A.

**Photometry.**

Measurement of Illumination. Summary of a paper by Dr. Hugo Krüss, published in the *Journal für Gasbeleuchtung.* Illustrated discussion of the apparatus invented by Herr Anton Wingen, called an "illumination tester." 1400 w. Gas Wld—Dec. 20, 1902. No. 52735 A.

Notes on Working with an Illumination Photometer. Henry Fowler. Read at Manchester Dist. Inst. of Gas Engrs. Describes methods used by the writer, giving results of tests. 2400 w. Jour Gas Lgt—Dec. 9, 1902. No. 52725 A.

See Electrical Engng., Measurement.

**Purification.**

Gas Purification and Gas Purifiers. Pierre Plantinga. Discusses the capacity, arrangement, and construction of purifiers; purifying material, &c. Ill. 2000 w. Am Gas Lgt Jour—Jan. 19, 1903. No. 53062.

The Purification of Blast Furnace Gas. The first of a series of articles describing apparatus for purifying this gas. 1600 w. Ir & Coal Trds Rev—Jan. 9, 1903. Serial. 1st part. No. 53034 A.

**Tanks.**

A New Method of Constructing Tanks. Arthur Vye-Parminter. An illustrated description of the Cottincin system as applied to gas holder construction. 1000 w. Jour Gas Lgt—Dec. 9, 1902. No. 52721 A.

**Waste.**

Leakage or Preventable Waste. C. E. Jones. A discussion of the losses, charged to unaccounted-for gas, giving a table showing the percentage in 438 undertakings in the United Kingdom. 1000 w. Jour Gas Lgt—Dec. 9, 1902. No. 52722 A.

**Water Gas.**

Introduction of Water Gas into Coal-Gas Retorts. Abstract translation of an interesting paper by Herr C. Borchardt, published in the *Journal für Gasbeleuchtung.* 800 w. Jour Gas Lgt—Dec. 16, 1902. No. 52729 A.

## INDUSTRIAL ECONOMY

**Agriculture.**

Agricultural Engineering. Elwood Mead. Abstract of a paper before the Am. Assn. for the Adv. of Science. Showing the relation of engineering to the growth and prosperity of agriculture, and urging that schools of instruction be establshed. 2200 w. Eng News—Jan. 15, 1903. No. 53-051.

**Alaska.**

The Opening of the Territory of Alaska. Harrington Emerson. An illustrated review of the mining and agricultural possibilities of Alaska and the development possible with the arrival of adequate transportation facilities. 3500 w. Engineering Magazine—February, 1903. No. 53287 B.

**Coal Trade.**

The Coal Trade for 1902. A general review by districts of the coal trade of Great Britain. 17500 w. Col Guard—Jan. 2, 1903. No. 52946 A.

**Cost Keeping.**

Cost Finding Methods for Moderate-Sized Shops. H. L. Arnold. A description of the system in practical use at the Cottrell printing press works, Westerly, R. I. 3500 w. Engineering Magazine—February, 1903. No. 53290 B.

**Education.**

The Training of an Engineer, or the Work of Students in a Technical School. Prof W. F. M. Goss. An interesting discourse on the education and work of an accomplished engineer. Ill. Discussion. 6300 w. Pro St. Louis Ry Club—Dec. 12, 1902. No. 52620.

**Eight-Hours' Day.**

Eight Hours (Bank to Bank). An exhaustive statement of the employers' position in regard to the Bill before the British Parliament, at a meeting of the coalowners with representatives of the Miners' Federation of Great Britain. 3800 w. Col Guard—Dec. 12, 1902. No. 52678 A.

**Employers.**

Moral Responsibility of Employers. Brief particulars of what the great firm of Krupp have done for their employees. 900 w. Jour Gas Lgt—Dec. 9, 1902. No. 52720 A.

**Factory Management.**

The Commercial Management of Factories. Ian Andrews. An analytical discussion of the relations of the office manager to the works, reviewing the conditions which affect the commercial success of manufcturing enterprises. 3000 w. Engineering Magazine—Feb., 1903. No. 53292 B.

**Industrial Development.**

The Tendency of Enterprise. Editorial discussion of an address of Mr. George Westinghouse, to the shareholders of the British Westinghouse Company. 2500 w. Engng—Dec. 19, 1902. No. 52686 A.

**Iron Trade.**

The Chicago Iron Trade in 1902. W. T. Partridge. A review of the year, the new enterprises developed, the outlook for the coming year, and subjects of related interest. 15000 w. Ir Age—Jan. 1, 1903. No. 52668.

The Philadelphia Iron Trade. Thomas Hobson. A review of the past year, discussing features of interest. 3700 w. Ir Age—Jan. 1, 1903. No. 52672.

The Pittsburg Iron Trade in 1902. Robert A. Walker. General review of conditions, new construction, finished material, prices, &c. 9700 w. Ir Age—Jan. 1, 1903. No. 52671.

**Labor Laws.**

New Zealand Labor Laws. A summary of the "industrial conciliation and arbitration act of 1900," with explanatory notes. 11500 w. U. S. Cons Repts. No. 1538—Jan. 7, 1903. No. 52622 D.

**Municipal Ownership.**

Success of Municipal Ownership in Great Britain. Robert Donald. A criticism of statements made by Mr. Robert P. Porter, and presentation of statistics to show the success of the present municipal ownership movement in Great Britain. Serial. 2 parts. 12000 w. St Ry Jour —Jan. 3 and 10, 1903. No. 53100 each D.

**Pension Plan.**

Pension Plan of the Canadian Pacific. Rules and regulations of a system put in operation Jan. 1, 1903, showing how it differs from those of American companies. 1600 w. Ry Age—Dec. 19, 1902. No. 52752.

**Profit Sharing.**

One Way to Cure the Trusts. Editorial discussion of the plan of the United States Steel Corporation devised to induce officers and employees to become stockholders. 1700 w. R R Gaz—Jan. 9, 1903. No. 52927.

United States Steel to Share Profits. A copy of the circulars to stockholders and employees setting forth the plan. 4500 w. Ir Age—Jan. 8, 1903. No. 52-676.

**Tariff.**

The New German Tariff Law. (Das Neue Zolltarif-Gesetz). The full text of the new German tariff law, with note showing its bearing upon the iron and steel trade. 2500 w. Stahl u Eisen—Jan. 1, 1903. No. 53258 D.

**Trusts.**

Industrial Trusts. Prof. W. Smart. Discusses the economy and monopoly of trusts as the good and bad features, showing their tendency to eliminate all unnecessary expenses in the production and distribution of goods, and also their power over price, improvements and labor. General discussion. 9500 w. Jour Soc of Arts —Jan. 16, 1903. No. 53143 A.

## MARINE AND NAVAL ENGINEERING

**Battleships.**

Comparison of the Battleships of the World. Gives a diagram, prepared in the Bureau of Naval Intelligence for the purpose of giving a graphic representation of the comparative homogeneity of the different classes of battleships of the principal naval powers. 1000 w. Sci Am Sup—Jan. 17, 1903. No. 53047.

The Battleships of the Future. Lewis Nixon. Discusses probable changes, the influence of the submarine boat, &c. 2700 w. World's Work—Jan., 1903. No. 52-630 C.

The Chilian Battleship "Libertad." Gives the general dimensions of the vessel; its armor and armament, and illustrated description of the engines. 1100 w. Engng —Jan. 16, 1903. No. 53082 A.

The New German Battleships "H" and "J." Illustrated description of battleships of a modified Wittelsbach type, with comments. 1500 w. Engr, Lond—Dec. 19, 1902. No. 52697 A.

The Reconstructed Turkish Battleship Messoudiyeh. Illustration and brief description of an old battleship converted into an armored cruiser. 500 w. Engr, Lond—Jan. 16, 1903. No. 53087 A.

Warship Building in 1902. A review of the work of the British Navy for the year just ended. 5200 w. Engng—Dec. 19, and 26, 1902. Serial. 2 parts. No. 52687 each A.

**Boats.**

The Construction of Small Sail Boats for Inland Waters. (Mittheilungen über den Bau Kleiner Segelboote für Binnenseen) W. E. Ernst. With diagrams of stability and lines of hull construction. 6000 w. Zeitschr d Oesterr Ing u Arch Ver —Dec. 12, 1902. No. 53218 B.

**Boilers.**

See Mechanical Engineering, Steam Engineering.

**British Navy.**

Naval Officers. Memorandum dealing with the entry, training, and employment of officers and men of the Royal Navy and of the Royal Marines. Also editorial. 15500 w. Engng—Jan. 2, 1903. No. 52939 A.

The New Admiralty Scheme. Carlyon Bellairs. A discussion of the coming changes in the Royal Navy and Royal Marines. 2000 w. Engr, Lond—Jan. 2, 1903. No. 52942 A.

**Cruisers.**

The New Armored Cruisers "Tennessee" and "Washington." Illustrations and descriptions of these vessels and their armament. 1600 w. Sci Am—Dec. 27, 1902. No. 52766.

The Novik, the Swiftest Cruiser in the World (Nowik, der Schnellste Kreuzer der Welt). Illustrated description of the 3000 ton cruiser built by Schichau for the Russian government, and which has made a trial speed of 26 knots on a 6 hour run and 27 knots on a measured mile. 1200 w. Schiffbau—Jan. 8, 1903. No. 53246 D.

**Electric Power.**

See Electrical Engineering, Power Applications.

**Explosion.**

Explosion on Oil-Tank Steamer Progresso. An illustrated account of the terrible accident at San Francisco, on Dec. 4, which caused great loss of life and total destruction of this vessel. 1400 w. Marine Engng—Jan., 1903. No. 52789 C.

**Fuel Oil.**

Memoranda Regarding Fuel Oil Aboard Ship. Walter J. Goodenough. Suggestions relating to bunkers, ventilation, piping, electric light, and furnace construction. 2500 w. Marine Engng—Jan., 1903. No. 52790 C.

**Governors.**

See Mechanical Engineering, Steam Engineering.

**Gun Distribution.**

The Distribution of Guns in Battleships. John Leyland. A discussion of the armament of battleships, with plans of some of the latest vessels of this class. 4000 w. Page's Mag—Jan., 1903. No. 53109 B.

The Gun-Power of Battleships. A comparison of the new battleship built for the Chilian Navy with others of approximately the same size, with a view of showing the armament, the principal protection and the speed given for the displacement tonnage allowed. 2000 w. Engng—Jan. 9, 1903. No. 53025 A.

**Japan.**

Dockyard and Engine Works at Nagasaki. Illustrated detailed description of these docks and shipbuilding works, with interesting information concerning this port. 1500 w. Engng—Jan. 9, 1903. No. 52998 A.

**Launches.**

The Design of Motor Launches. W. F. Durand. Considers briefly the design of form and of its relation to resistance, stability, capacity, and safety. 7500 w. Marine Engng—Jan., 1903. No. 52792 C.

**Navipendulum.**

The Navipendular Method of Experiment as Applied to Some Warships of Different Classes. (Il Methodo degli esperimenti Navipendulari Applicato ad Alcune Navi da Guerra). G. Russo. The full Italian text of the author's paper presented in English at the meeting of the Institution of Naval Architects in March, 1902. 10000 w. 3 plates. Rivista Marittima—Dec., 1902. No. 53282 H.

**Navy Yard.**

Developing a British War Post. Archibald S. Hurd. A well-illustrated account of the construction of basins, drydocks, etc., in the Keyham dockyard, at Devonport, England. 2500 w. Cassiers Mag—Jan. 1903. No. 52802 B.

**Penobscot River.**

Steamboating on the Penobscot. A review of the boats navigating this river; the first appearing on May 26, 1824. 3700 w. Marine Rev—Dec. 25, 1902. No. 52764.

**Projectiles.**

Capped and Uncapped Propectiles. Illustrations showing the effect of the impact of capped and uncapped projectiles with particulars of the test. 900 w. Engr, Lond—Jan. 2, 1903. No. 52945 A.

**Resistance.**

Experiments upon the Resistance of a Screw Steamboat. (Versuche mit einem Schraubendampfer hinsichtlich des Widerstandes im Freien Wasser). H. Enno van Gelder. Data and results of dock trials of a steamboat at Kinderdyk, near Rotterdam. Two articles. 4000 w. 1 Plate. Schiffbau—Dec. 23,1902. No. 53245 each D.

**River Plate.**

Navigation of the Rio de la Plata. Information concerning the type of vessels needed, and the points of difficulty on the river. 600 w. U S Cons Repts, No. 1530—Dec. 27, 1902. No. 52623 D.

**Salvage.**

Modern Methods of Saving Ships. Morgan Robertson. An illustrated article showing how new inventions have made successful difficult wrecking operations. 2000 w. World's Work—Jan., 1903. No. 52628 C.

**Schooners.**

Fore and Aft Schooners. Theodore Lucas. An illustrated discussion of this type of vessel which has proved itself easier and cheaper to handle than the square rig. 1700 w. Naut Gaz—Jan. 1, 1903. No. 52776.

**Shipbuilding.**

German Shipbuilding Progress on the Weser. Briefly reviews the recent progress in size, number, speed and comfort of German ships, and the shipyards where they are built. 1200 w. U S Cons Repts, No. 1556—Jan. 28, 1903. No. 53155 D.

The New York Shipbuilding Company's Plant, Camden, N. J. Begins an illustrated description of a modern plant equipped for the construction of modern steel commercial and battleships. 3000 w. Eng Rec—Jan. 3, 1903. Serial, 1st part. No. 52909.

**Ship Yards.**

How to Plan, Organize and Operate a Modern Shipyard. Theodore Lucas. Discusses the organization, and ship-yard draughting rooms, and the general superintendence. 7500 w. Naut Gaz—Jan. 1, 1903. No. 52777.

**Sighting Device.**

The Grenfell Sighting and Signalling Gear. Illustrates and describes a sighting device and signalling gear for diminishing the duty demanded of the gunner, especially adapted to naval ordnance. 1600 w. Engng—Jan. 16, 1903. No. 53081 A.

**Steamers.**

Atlantic Transport Steamers Missouri and Maine. Description and plans of vessels under construction, and their engines. 1700 w. Marine Engng--Jan., 1903. No. 52793 C.

Great Eastern Railway Company's Steamer Brussels. Illustrates and describes this vessel which represents the latest practice in channel steamers. 2000 w. Engr, Lond—Jan. 9, 1903. No. 53028 A.

Reconstruction of the Steamship "New York." Illustrations and particulars of interesting reconstruction work. 900 w. Sci Am—Jan. 17, 1903. No. 53046.

**Submarines.**

Submarine Boats in the United States. Remarks on the official returns of the naval Board of Inspection in regard to the official trials of the Adder and Moccasin. 2000 w. Engr, Lond—Dec. 19, 1902. No. 52695 A.

The French Submarines. A critical editorial discussion of the types thus far tried and the French manœuvres. 3700 w. Engng—Jan. 9, 1903. No. 52996 A.

# MECHANICAL ENGINEERING

## AUTOMOBILES.

**Accumulators.**

Accumulators for Automobiles at the Düsseldorf Exposition (Die Akkumulatores für Elektromobilen auf der Austellung zu Düsseldorf). Hans Dominik. Giving details of the principal storage batteries used for electric vehicles in Germany and exhibited at Düsseldorf. 2500 w. Elektrochemische Zeitschr—Dec., 1902. No. 53273 G.

**Electric Vehicles.**

Design for an Electric Runabout. J. C. Brocksmith, M. E. A complete design for vehicle, motors and battery, with many illustrations. 4000 w. Am Elect'n—Jan. 1903. No. 53013.

Present Status of Electric Automobilism. Hayden Eames. An illustrated discussion of the advantages of electric delivery wagons, and a comparison with delivery wagons pulled by horses. 1200 w. Elec Wld & Engr—Jan. 10, 1902. No. 52-834.

**Exhibition.**

The Madison Square Garden Show. An illustrated article describing this very successful exhibition, some of the exhibits, the steam vehicles, the electric vehicles, etc. 9500 w. Horseless Age—Jan. 21, 1903. No. 53135.

**Flash Generators.**

The Action of Flash Generators in Use on a Motor Car. J. S. V. Bickford. A critical examination of their action and the points that affect their efficiency. 3000 w. Horseless Age—Dec. 24, 1902. No. 52748.

**France.**

Motor Car Developments in France. A review of the progress during the year, as shown in the vehicles on exhibition at the

Paris show of motor vehicles, with remarks on features of interest. Ill. 2000 w. Engr, Lond—Dec. 19, 1902. Serial. 1st part. No. 52696 A.

**Ignition.**

Features and Failures of Ignition. Reginald Wales. On the troubles with batteries, sustaining rods and induction coils. Ill. 2000 w. Auto Mag—Jan., 1903. No. 52646 C.

Magneto-Electric Ignition. L. Baudry de Saunier. From *La Locomotive*. A practical analysis of the peculiarities of such ignition, explaining how these machines operate, and the advantages. Ill. 2000 w. Auto Topics—Dec. 20, 1902. Serial. 1st part. No. 52614.

**Indicators.**

The M'Innes-Dobbie Indicator and Mathot Recorder. Shows the advantage of obtaining accurate indicator diagrams from automobile engines and gives illustrated descriptions of the instruments named. 3000 w. Auto Jour—Dec. 27, 1902. No. 52711 A.

**Light-Weight.**

Leading Types of 1902. French Light-Weight Automobiles. Illustrates and describes some of the cars that have found favor during the last year. 2000 w. Sci Am—Dec. 27, 1902. No. 52767.

**Municipal Wagons.**

Municipal Motor Wagons. Archibald Sharp. Read at the Sanitary Inst. Cong., Manchester, England. On the types of vehicles for municipal service, such as the collection of refuse, water sprinkling, street sweeping, removal of snow, etc., their cost and advantages. Ill. 4400 w. Mech Engr—Dec. 27, 1902. No. 52738 A.

**New Model.**

Winton 1903 Model. An illustrated description of a 20 h. p. machine and its equipment. 2800 w. Auto Topics. Dec. 27, 1902. No. 52625.

**Packard Car.**

The Packard 12-Horse Power Car. Herbert L. Towle. Illustrated description of this machine. 2800 w. Automobile—Jan. 17, 1903. No. 53061.

**Paris Salon.**

An American Impression of the Paris Show. Joseph Tracy. Notes the features that impressed the writer in the machines exhibited. 1800 w. Horseless Age—Dec. 31, 1902. No. 52749.

The Annual A. C. F. Show in Paris. An illustrated report of exhibits and matters of interest. 7800 w. Auto Jour—Dec. 20, 1902. Serial. 1st part. No. 52710 A.

The Paris Autocar Show. An illustrated description of exhibits, special features, and matters of interest. 13700 w. Autocar—Dec. 20, 1902. No. 52717 A.

The Paris Salon in Text and Pictures. An illustrated account of things and incidents which bear upon the development of automobilism in the United States or illustrate the condition of the movement in France. 3500 w. Automobile—Jan. 3, 1903. No. 52602.

**Petrol Car.**

The Lanchester Motor Car. Illustrated detailed description of a new gasoline vehicle having characteristic features of interest. 3000 w. Engng—Jan. 16, 1903. No. 53080 A.

The Pipe Petrol Car. An illustrated detailed description of a recent vehicle manufactured in Brussels. 1800 w. Auto Jour—Dec. 20, 1902. No. 52709 A.

The Velox 12-H. P. Petrol Car. Begins an illustrated detailed description of an English car of recent design. 2400 w. Auto Jour—Jan. 10, 1903. Serial. 1st part. No. 52986 A.

The Wartburg Light Petrol Cars. Illustrated descriptions of two private cars of strong construction with twin-cylinder engines. 2800 w. Auto Jour—Jan. 3, 1903. No. 52933 A.

**Petrol Motor.**

The Internal Combustion Engine. An illustrated explanation of the principles of the petrol motor. 1600 w. Autocar—Dec. 27, 1902. No. 52718 A.

**Power Truck.**

A New Power Truck. Illustrates and describes the Morgan motor trucks and gives comparison of the cost of haulage by horses and by motor trucks. 2500 w. Ir Trd Rev—Dec. 25, 1902. No. 52856.

**Speed Gearing.**

The De Dion-Bouton Three-Speed Gear. Lettered drawings, illustrations and description of this method of obtaining three forward speeds and a reverse. 1200 w. Autocar—Dec. 13, 1902. No. 52716 A.

**Steam Lurrey.**

A Simpson and Bibby Steam Lurrey for West Africa. Illustration and description of a 5-ton steam wagon to be used for transporting mining material between the coast and gold fields. 600 w. Auto Jour—Dec. 13, 1902. No. 52708 A.

**Steam Vehicles.**

Present Status of Steam Vehicles. Hugh Dolnar. An illustrated review of the use of the steam engine for wagon driving, considering it the most suitable motive agent now before the public. 2000 w. Automobile—Jan. 24, 1903. No. 53145.

The Prescott Steam Carriage. Herbert L. Towle. Illustrated description of a vehicle representative of present practice in American steam carriages. 2300 w. Automobile—Jan. 10, 1903. No. 52965.

**Voiturette.**

The 6-H. P. De Dion-Bouton Voiturette. An illustrated detailed description of a recent light car. 900 w. Autocar—Dec. 27, 1902. No. 52719 A.

## HYDRAULICS.

**Electric Pumping.**

See Electrical Engineering. Power Applications.

**Governors.**

The Governing of Water Powers. Allan V. Garratt. Reviews in a general way the most significant improvements made in governing water-wheels and the present possibilities of their regulation. 2800 w. Engr, U S A—Jan. 1, 1903. No. 52977.

**Hydraulic Machinery.**

Hydraulic Machinery for an Indian Locomotive Works. Illustrations and descriptions of a locomotive wheel press and a spring-testing machine, both supplied with special electrically-driven pumps. 600 w. Engr, Lond—Jan. 2, 1903. No. 52943 A.

**Pipes.**

Calculations for Pipes and Fittings (Calculs des Parois et Armatures des Tuyaux). C. Birault. A study of the stresses upon pipes laid upon the ground considering both the weight of the empty pipe and the effect of its contents. Two articles. 4000 w. Génie Civil—Dec. 13, 20, 1902. No. 53206 each D.

**Plumbing.**

Piping a Double Boiler. An illustrated description of a vertical boiler and its attendant piping with an account of the work done. 1400 w. Met Work—Jan. 3, 1903. No. 52608.

**Progress.**

Progress in Hydraulic Power Development. J. T. Fanning. Reviews the development, especially the achievements of the last twenty-five years. 3300 w. Eng Rec —Jan. 3, 1903. No. 52915.

**Water Power.**

The Development of Mountain Water Powers. Paul Letheule. An illustrated description of the hydraulic power possibilities of the French Alps, and an account of the developments in the district about Grenoble. 4000 w. Engineering Magazine—February, 1903. No. 53288 B.

The White Coal Congress (Congrès de la Houille Blanche). Ch. Pinal. A full account of the proceedings of the congress which investigated the water power available in the French Alps. 15000 w. Mem Soc Ing Civ de France—Nov., 1902. No. 53281 G.

Water Power Development. W. F. Durand. Briefly considers the important features of hydro-electric power plants as applied to modern installations 5800 w. Engr, U S A—Jan. 1, 1903. No. 52976.

See also Electrical Engineering, Generating Stations, under local names.

## MACHINE WORKS AND FOUNDRIES.

**Bearings.**

Steel Ball Bearings. Gives illustrated descriptions of these bearings with theoretical deductions by Dr. Heerwagen to ascertain the distribution of the load upon the different balls of a bearing. 3400 w. Engng—Dec. 26, 1902. No. 52690 A.

**Boring Bar.**

A Portable Boring Bar. Illustrated description of a machine designed for boring out stationary engine, locomotive, and pump cylinders without removing the cylinder from the frame or bed. 800 w. Am Mach—Jan. 1, 1903. No. 52783.

**Cost Keeping.**

See Industrial Economy.

**Cupolas.**

Long Heats in Small Cupolas. C. K. Weller. Considers some of the things that cause cupolas to bung up and shorten the time it can be kept in blast and gives suggestions for the proper management. 1400 w. Foundry—Jan., 1903. No. 52642.

**Dies.**

Cut and Carry Dies. G. Schneider. Describes and illustrates a die for making washers for bicycle rims, and its operation. 500 w. Am Mach—Jan. 1, 1903. No. 52-786.

Feeding Sheet Metal to Dies. Joseph V. Woodworth. Illustrates and describes the various devices. 1500 w. Am Mach—Dec. 25, 1902. Serial. 1st part. No. 52-782.

**Drills.**

Twist Drills. Corneil Ridderhof. Considers points relating to drills, their grinding, the stresses, etc. 2000 w. Am Mach —Jan. 1, 1903. No. 52784.

**Drop Hammers.**

Notes on the Evolution of the Drop Hammer for Die Forging. E. W. Merrill, Jr. An illustrated review of the development of this tool which is extensively used, especially describing the Brett drop-hammer. 1800 w. Eng News—Jan. 1, 1903. No. 52883.

**Electric Driving.**

See Electrical Engineering, Power Applications.

**Engine Construction.**

Fundamental Differences in the Construction of Gas and Steam Engines. **P.**

Plantinga. Shows the difference in working conditions calls for entirely different designs and constructions. 1500 w. Eng News—Jan. 15, 1903. No. 53056.

**Factory Management.**

See Industrial Economy.

**Fan Blowers.**

The Fan Blower and Its Application to the Cupola Furnace. R. B. Hayward. Read before the Pittsburg Foundrymen's Assn. An explanation of the forms of fan used for the movement of air, the laws under which the forces act, the problems encountered, etc., especially as applied to the cupola. 4200 w. Ir Age—Jan. 8, 1903. No. 52673.

**Feeds.**

Feeds and Speeds. Stanley H. Moore. Outlines the method used in the attempt to secure some definite knowledge on this subject. Diagrams. 1100 w. Am Mach—Dec. 25, 1902. No. 52781.

**Forgings.**

The Action of Iron and Steel Under Different Degrees of Heat. Gives an illustrated account of investigations which seem to establish that wrought iron is stronger when at a white heat than when at a red heat. 1800 w. Am Mach—Dec. 25, 1902. No. 52779.

**Foundry Management.**

Foundry Management in the New Century. Robert Buchanan. Mr. Buchanan's third paper discusses in detail the operations of moulding both by hand and by machine, with numerous illustrations. 4500 w. Engineering Magazine—February, 1903. No. 53289 B.

**Gear Cutters.**

Cut Gearing and Some American Machinery for Its Manufacture. Oscar J. Beale. A discussion of cut gearing and the causes of its noisiness, and illustrated descriptions of many gear-cutting machines. 3000 w. Cassier's Mag—Jan., 1903. No. 52803 B.

**Grinding.**

Two German Grinding Machines. Illustrates and describes a cylindrical grinding machine for internal grinding, and a link grinding machine which possess points of novelty. 700 w. Am Mach—Jan. 22, 1903. No. 53072.

**Machine Tools.**

Heavy Machine Tools at the Düsseldorf Exposition (Die Düsseldorfer Austellung —Die Riesen Werkzeugmaschinen). H. Unger. With illustrations of heavy milling, boring and planing machines; also lathes and special tools. Two articles. 6000 w. Glasers Analen—Jan. 1, 15, 1903. No. 53228 each D.

Machine Tool Progress. C. W. Obert. The present article gives illustrated descriptions of feed and drive mechanisms. 1500 w. Am Engr & R R Jour—Jan., 1903. Serial. 1st part. No. 52855 C.

**Manholes.**

The Weakening of Cylindrical Vessels by Cutting Manholes (Zwei Versuche zur Klarstellung der Verschwächung Zylindrischer Gefässe durch den Mannlochausschnitt). C. Bach. Data and results of experiments to test the reduction in strength due to non-reinforced manhole openings. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 3, 1903. No. 53203 D.

**Molding.**

The Advances in Molding Machinery. Harris Tabor. On the improvements and the future of molding machines. Ill. 1600 w. Ir Age—Jan. 1, 1903. No. 52670.

**Piece Work.**

Piece Work in Railway Shops. Gus Giroux. Read before the Canadian Ry Club. Shows the advantages of this system and gives suggestions for introducing it. 3500 w. Ry Age—Dec. 26, 1902. No. 52756.

**Pneumatic Tools.**

Applications of Compressed Air in Workshops (Emploi de l'Air Comprimé dans les Chantiers de Construction). A. Abraham. Describing compressing plant, reheaters and various forms of pneumatic tools, especially as used in the erection of structural work. Two articles. 4500 w. Génie Civil—Dec. 20, 27, 1902. No. 53-208 each D.

**Railway Shops.**

See Street and Electric Railways.

**Risers.**

Should a Riser be Open or Shut? James A. Murphy. Discusses when the riser should be left open and when closed, and gives suggestions of interest to molders. 1500 w. Foundry—Jan., 1903. No. 52643.

**Rivetting.**

Efficiencies of Riveted Lap Joints. C. G. Robbins. Gives tables covering both single and double-riveted lap joints of plates from ¼ to ½ inch in thickness, rivets from ½ to 1 inch in diameter, and pitches varying by sixteenths of an inch from 1¾ inches to 4⅜ inches, with explanation. 1500 w. Power—Jan., 1903. No. 52797 C.

**Screw Machine.**

2x12-inch Screw Machine. Illustrated description of a machine designed for handling long pieces and its equipment of tools being applicable to all classes of work requiring such operations as turning, threading, etc. 1300 w. Am Mach—Dec. 25, 1902. No. 52780.

**Screw-Threads.**

The Milling-Cutter Applied to the Production of Screw-Threads Illustrates and describes a new method of screw-cutting, and the special machine for carrying it out; the new feature being the use of a milling cutter for forming the thread. 2500 w. Ill. Eng News—Jan. 1, 1903. No. 52882.

**Sheet Metal.**

Horning and Seaming Processes. Joseph V. Woodworth. Illustrates and describes some of the devices and fixtures used. 1300 w. Am Mach—Jan. 1, 1903. No. 52785.

**Shop Management.**

Some Features of the Labor System and Management at the Baldwin Locomotive Works. John W. Converse. From an address before the Am. Acad. of Pol. & Soc. Sci., Phila. Describes methods adopted and features of interest. 4000 w. Ry & Engng Rev—Jan. 3, 1903. No. 52868.

**Shop Records.**

The "Duca" Card System. Robert Grimshaw. Gives card forms used by a German machinery manufacturer for keeping an account of office and shop items, with explanatory notes. 1900 w. Ir Trd Rev—Jan. 1, 1903. No. 52857.

**Staybolted Surfaces.**

Strength of Curved Staybolted Surfaces. C. G. Robbins. Explains the method of determining the safe working pressure of such surfaces. Ill. 3800 w. Power—Jan., 1903. No. 52850 C.

**Tack-Making.**

Plant of the Atlas Tack Company, Fairhaven, Mass. Illustrated detailed description of a carefully planned factory, equipped with automatic machinery, a modern power plant, and methods of power transmission. 2800 w. Eng Rec—Jan. 17, 1903. No. 53066.

**Tramrail Systems.**

Overhead Tramrail Systems in Shops and Foundries. A. W. Moyer. Read before the Philadelphia Foundrymen's Assn. An illustrated article showing the overhead tramrail to be an important labor saving factor, and describing briefly the kinds of rail most used and a few installations 4600 w. Ir Age—Jan. 22, 1903. No. 53068.

**Tubes.**

Some Recent Inventions Relating to the Manufacture of Iron and Steel Tubes. Edward C. R. Marks. The present article considers billet-piercing processes. Ill. 1700 w. Prac Engr—Dec. 26, 1902. Serial. 1st part. No. 52715 A.

**Wire Nails.**

Wire Nail Machines. Illustrated description of two recent machines which prevent waste and greatly increase the output. 2000 w. Ir & Coal Trds Rev—Jan. 16, 1903. No. 53090 A.

**Work Shops.**

The Designing and Construction of Modern Engineering Workshops. J. H. Humphreys. Read before the Manchester (England), Assn. of Engrs. An illustrated discussion of stanchions, crane girders, floors and floor girders, roof principals, and bracing 4500 w. Mech Engr—Dec. 13 and 20, 1902. Serial. 2 parts. No. 52-737 each A.

## MATERIALS OF CONSTRUCTION.

**Alloys.**

Industrial Alloys. Percy Longmuir. The present article considers modern steels as alloys, indicating the processes by which they are made. Also begins a discussion of copper alloys. 1500 w. Prac Engr—Jan. 2, 1903. Serial. 1st part. No. 52932 A.

**Lubricants.**

Oil vs. Grease as a Lubricant for the Plungers of Pumping Engines. William M. Davis. Gives an account of tests made with these lubricants which prove conclusively that the friction loss by use of grease is excessive. 900 w. Power—Jan., 1903. No. 52796 C.

Testing of Lubricants and Metals for Bearings (Méthode pour l'Experimentation des Huiles et Métaux pour Coussinets). Pierre Breuil. A discussion of the method of Dettmar, based upon the number of turns made by a free journal after disconnection. 2000 w. Génie Civil—Dec. 13, 1903. No. 53207 D.

**Nickel Steel.**

Investigations on Nickel Steel (Recherches sur les Aciers au Nickel). A. Pourcel. A note upon the investigations of Dumas regarding the bearing of the behavior of the high tension nickel steels upon the solution theory. 1000 w. Génie Civil—Dec. 27, 1902. No. 53211 D.

**Testing.**

A New Method of Testing Rails (Nouvelle Méthode d'Essai des Rails). Ch. Frémont. Describing the application of the nicked bar drop test to the investigation of steel rails. 1200 w. Comptes Rendus—Jan. 5, 1903. No. 53242 D.

**Tool Steel.**

High-Speed Tool Steel. An account of tests made to ascertain the increased efficiency obtained by the use of high-speed tool steel, and also the extra power required to drive the machines at the increased speed. 1500 w. Engng—Jan. 16, 1903. No. 53083 A.

Notes on High Speed Steel (Einige Betractungen über Schnelldrehstahle). Giving tabulated results of tests of the Bischoff steel, at cutting speeds of 16 to 64 metres per minute. 1500 w. Ill. Zeitschr f Klein u Strassenbahnwesen—Dec. 16, 1902. No. 53285 D.

**Wire Rope.**

Rules for Working Loads of Wire Elevator Ropes. H. C. Newcomer. A statement giving information for determining the sizes of wire ropes and stresses for passenger elevators. 2200 w. Eng News —Jan. 15, 1903. No. 53052.

## MEASUREMENT.

**Dynamometer.**

New Dynamometer for Road Traction Experiments. An illustrated description of a dynamometer fitted to an automobile, used by a British Association committee in traction experiments. 2000 w. Feilden's Mag—Jan., 1903. No. 53113 B.

See also Electrical Engineering Measurement.

**Engine Tests.**

A Remarkable Steam Engine Test. Report of a series of tests made by Prof. J. A. Ewing on an engine supplied with superheated steam. 1300 w. Engr, Lond —Jan. 9, 1903. No. 53033 A.

**High Pressures.**

The Estimation of High Pressures. Illustrated description of a new form of deadweight pressure gauge for the estimation of high pressures. 700 w. Engng —Jan. 9, 1903. No. 52995 A.

**Planimeter.**

The Planimeter, Explained Simply, Without Mathematics. W. J. Tennant. Abstracted from a paper read before the Inst. of Jr. Engrs. Explains the use of this instrument in making calculations. Ill. 2500 w. Engr, Lond—Jan. 16, 1903. No. 53089 A.

**Recorders.**

Autographic Load-Strain Recorder for Test Specimens. Prof. Goodman. Illustrates and describes an apparatus entirely automatic in its action. 1500 w. Engng—Dec. 19, 1902. No. 52684 A.

**Weight.**

The Weight of Solids of Revolution. George F. Summers. Brief illustrated description of an arrangement that performs computations automatically. 300 w. Am Mach—Jan. 15, 1903. No. 53049.

## POWER AND TRANSMISSION.

**Belting.**

Power Transmission by Leather Belting (Transmissions par Courroies en Cuir). M. Gruffe. A mathematical analysis, with graphical diagrams enabling the capacity for various speeds and tensions to be seen. 1800 w. Revue Technique—Dec. 25, 1902. No. 53217 D.

**Compressed Air.**

Efficiency Tests of Compressed Air Machinery. W. C. Popplewell. Gives an illustrated detailed description of the methods employed and appliances necessary for tests of the different branches of a compressed air installation. 2300 w. Mech Engr—Jan. 10, 1903. Serial. 1st part. No. 52988 A.

**Conveyors.**

Computations for Screw Conveyors (Calculs Relatifs aux Transports par vis d'Archimède). J. E. Delliac. With practical examples, showing the transporting capacity of helical screw conveyors, for various dimensions and speeds. 1200 w. Revue Technique—Dec. 25, 1903. No. 53-216 D.

Some American Conveying Machinery (Ueber Einige Amerikanische Umladevorrichtungen). R. Mellin. Illustrated description of modern American appliances for handling, conveying, and storing iron ore, coal, etc. 4500 w. 6 plates. Glückauf—Dec. 13, 1902. No. 53237 D.

**Dynamometer.**

See Electrical Engineering, Measurement.

**Friction.**

On Bearings for High Speeds. O. Lasche. A translation of a paper in the *Zeitschrift des Vereines Deutscher* Ingenieurs, giving the results of experiments on journal bearings made by the Allegemeine Elektricitäts-Gesellschaft, Berlin. 20,000 w . 8 plates. Trac & Trans—Jan., 1903. No. 53042 E.

**Shafts.**

Lining Up Shafts. H. J. Teiper. Gives suggestions for the lining up of shafting, favoring the lining up by the couplings. Suggestions apply not only to marine engines, but to stationary engines also. 2000 w. Power—Jan., 1903. No. 52798 C.

## SPECIAL MOTORS.

**Efficiency.**

Cause of Increased Consumption in Gas and Gasoline Engines. Albert Stritmatter. Attributes the trouble to the lack of proper care. 1800 w. Am Mfr—Dec. 25, 1902. No. 52747.

**Gas Engines.**

Brake Horse-Power Combined Gas and Oil Engine (Butler's Patents). Illustrated description of an engine instantly interchangeable from town gas to kerosene oil, while running, without even having to switch off the electric lights for a moment. 500 w. Engng—Dec. 26, 1902. No. 52691 A.

Development of Gas Engines of Large Units. Fred B. Wheeler. Considers the subject in regard to natural gas, producer gas, illuminating gas, and blast furnace gas; also pumping engines for natural gas and for water, central station use, and general power purposes. Ill. 2000 w. Ir Age—Jan. 1, 1903. No. 52667.

Important Gas Engine Installation. Gives an illustrated description of the Koerting gas engine of 1000 h. p., built for the Lackawanna Steel Co., Buffalo. There will be 8 engines of this size and 16 of 2000 h. p. each, all operated by blast furnace gas. 2800 w. Mach, N Y—Jan., 1903. No. 52858.

The Gas Engine—Availability of Power Gas. B. H. Thwaite. Reviews the work of the writer in this field, and also of other experimenters, showing the differences between the ideal power gases and other gases in use, the progress in gas engines, and the advantages of the new power gas system. Ill. 6000 w. Engr, U S A—Jan. 1, 1903. No. 52975.

The Use of Blast Furnace Gas in Gas Engines. Cecil Cochrane. Abstract of a paper read at meeting of Cleveland Inst. of Engrs. at Middlesbrough, Eng. Describes an engine in operation at the Ormesby ironworks, and the results of official trials of a gas-blowing engine, and methods employed. 1900 w. Col Guard—Dec. 19, 1902. No. 52680 A.

Varieties in the Design of Large Gas Engines (Verschiedene Constructionen von Grossgasmotoren). A communication from Herr Joh. Körting, discussing the construction and action of large gas engines, with especial reference to the mixture of the charge. 1800 w. 4 plates. Stahl u Eisen—Dec. 15, 1902. No. 53251 D.

**Gas Power.**

Furnace-Gas Motors at the Düsseldorf Exposition 1902 (Die Gichtgasmotore auf der Austellung Düsseldorf, 1902). W. Hübbe. With numerous illustrations of the various large engines exhibited for use with waste gases of blast furnaces. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 19, 1902. No. 53220 B.

**Hydrocarbon Motors.**

See Street and Electric Railways.

**Petrol Motor.**

See Mechanical Engng., Automobiles.

## STEAM ENGINEERING.

**Boiler Explosions.**

A Remarkable Boiler Explosion. A discussion of the cause of the explosion at Swift & Co.'s, in Chicago, Nov. 29, 1902. 3000 w. Engr, Lond—Jan. 9, 1903. No. 53029 A.

Boiler Explosion in the Tow Boat Hermine (De Ontploffing van den Ketel in de Sleepboot Hermine). An account of a disastrous explosion of a cylindrical marine boiler, with photographs and detailed drawings. 2000 w. De Ingenieur—Dec. 13, 1902. No. 53247 D.

**Boilers.**

A New Departure in British Cruiser Machinery. The Question of Water-Tube Boilers. George Holliday. A well-illustrated description of various types of marine boilers and of the ships, both British and of other nations in which they are fitted. 5500 w. Cassier's Mag—Jan., 1903. No. 52801 B.

Concerning Naval Boilers. Substance of the report of the committee appointed by the British Admiralty to investigate the matter of boilers for use in the British navy. Ill. 3500 w. Locomotive—Nov., 1902. No. 52624.

Modern Boiler Practice. Charles H. Benjamin. Reviews the lines along which improvements have been made, the types at present in favor, improvement in setting of boilers, the use of mechanical stokers, and other appliances, with the results obtained. 2200 w. Engr, U S A—Jan. 1, 1903. No. 52974.

Modern Marine Boilers. H. M. Rounthwaite. Read before the Jr. Inst. of Engrs. Considers three types of boilers; the ordinary cylindrical, the "express" type of water-tube boiler, and the "ordinary" water-tube. 7500 w. Engr, Lond—Jan. 9, 1903. No. 53032 A.

Steam Boilers and Engines at the Düsseldorf Exposition (Les Chaudières et les Machines à Vapeur à l'Exposition de Düsseldorf). Ch. Compère. A comprehensive review of the steam machinery at Düsseldorf, showing the progress made since 1900. 12000 w. 2 plates. Mem Soc Ing Civ de France—Nov., 1902. No. 53280 G.

Sugden's Water-Tube Boiler. Illustrates and describes a new boiler possessing interesting features. 800 w. Engng—Jan. 2, 1903. No. 52935 A.

The Capacity of Cast Iron Sectional Steam Boilers. J. J. Blackmore. Paper presented at meeting of the Am. Soc. of Heat. & Ven. Engrs. Proposes a basis for establishing a standard rating for sectional cast-iron heaters in such terms as to enable the engineer to compare the performance of various makes. 1200 w. Eng Rec—Jan. 24, 1903. No. 53158.

The Seating of Lancashire Boilers. An illustrated article discussing points of importance in boiler setting. 1400 w. Prac Engr—Jan. 9, 1903. No. 52987 A.

Water-Tube Boilers. An illustrated discussion of the Belleville boiler, the Thornycroft water-tube boiler and the Yarrow boiler. 8000 w. Sci Am Sup—Dec. 27, 1902, and Jan. 3, 1903. Serial, 2 parts. No. 52770.

**Condensing.**

A "Towerless Cooling Tower" and Surface Condenser Combined. Illustrated description of a novel system of condensing for steam engines, particularly applicable where the supply of condensing water is limited, and where space available forbids the use of a cooling tower. 1200 w. Eng News—Dec. 25, 1902. No. 52875.

**Connecting Rods.**

Connecting and Coupling-Rods. P. H. Parr. Gives the results of an original analysis of the stresses in the connecting-rods and coupling rods of locomotives, indicating the methods of investigation used. 1200 w. Engr, Lond—Jan. 16, 1903. Serial. 1st part. No. 53085 A.

**Engine.**

Improved Poppet-Valve Engine (Neuerungen au Dampfmaschinen mit Ventilsteuerungen). Fr. Freytag. Illustrated description of the Lentz steam engine, using a combined eccentric and cam valve gear with poppet valves. 3500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Dec. 20, 1902. No. 53200 D.

The Machinery of the Orient-Pacific Liner "Orontes." Illustration, with description, of one of the twin sets of quadruple-expansion engines, and a general description of the vessel. 1200 w. Engng—Jan. 2, 1903. No. 52938 A.

The Reciprocating Steam Engine—Its Status, Its Rivals, and Its Apparent Future. R. H. Thurston. Reviews the development of the steam engine and the wide field is has occupied, commenting briefly on the rivalry of gas engines and steam turbine. 2800 w. Engr, U S A—Jan. 1, 1903. No. 52973.

The Williams Engine. Illustrated description of a new type of vertical compound engine. 1500 w. Power—Jan., 1903. No. 52795 C.

2000-Horse-Power Twin Tandem Steam Engine. An illustrated description of an engine exhibited at Düsseldorf which was built by the Grevenbroich Company. 700 w. Engng—Jan. 9, 1903. No. 52997 A.

**Engine Construction.**

See Mechanical Engineering, Machine Works and Foundries.

**Engine Tests.**

See Mechanical Engng., Measurement.

**Entropy.**

Entropy. J. Swinburne. An elaboration of the views expressed in the author's recent presidential address before the Inst. of Elec. Engrs., attacking the ordinary definitions of entropy based on completely reversible thermo-dynamic processes. 3500 w. Elec Rev, Lond—Jan. 9, 1903. No. 53125 A.

**Firing.**

Comparative Economy of Stoking and Hand Firing. Julius Geldard. Particulars of tests with account of the measuring methods employed. Ill. 2700 w. Mech Engr—Jan. 3, 1903. No. 52931 A.

**Governors.**

Marine Engine Governors. Jasper E. Cooper. Illustrated descriptions of different governors for marine steam engines. 3500 w. Feilden's Mag—Jan., 1903. No. 53112 B.

**Heat Transmission.**

The Relation of Heat Emission to Steam Pressure (Zur Generellen Regelung der Wärmeabgabe der Heizkörper bei Niederdruck durch die Höhe der Dampfspannung). O. Hunaeus. A discussion of the author's formulas in view of their use by Prof. Rietschel; with response by the latter. 3000 w. Gesundheits-Ingenieur—Dec. 31, 1902. No. 53243 B.

**Liquid Fuel.**

Liquid Fuel for Electrical Stations. W. H. Booth. A general discussion of the question of oil fuel. 2500 w. Elec Rev, Lond—Jan. 2, 1903. No. 52816 A.

**Rotary Engine.**

The Hult Rotary Steam Engine. Illustrated description of an engine in which the cylinder participates in the rotary motion of the piston, and which is now being made in sizes up to 250 horse power. 1800 w. Feilden's Mag—Jan., 1903. No. 53116 B.

**Steam Plants.**

The Development of Steam Power Plants. George H. Barrus. Discusses the important changes during the last twenty-five years. 2500 w. Eng Rec—Jan. 3, 1903. No. 52916.

The Modern Plant. W. H. Wakeman. Practical directions and suggestions concerning its design and operation, and means of determining the size of a plant to develop a given power. 2000 w. Mod Mach—Jan., 1903. No. 52604.

**Steam Turbine.**

Progress in the Introduction of the Steam Turbine. J. R. Bibbins. A review of the development of the various forms of steam turbine in actual use, with especial reference to work in the United States. 4000 w. Engineering Magazine—February, 1903. No. 53293 B.

The Steam Turbine and the Future of Heat Engines (Die Dampfturbinen und die Aussichten der Wärmekraftmaschinen). A. Stodola. A discussion of the thermodynamic and mechanical features of the steam turbine, showing its influence upon the development of heat motors. Serial, Part I. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 3, 1903. No. 53201 D.

**Superheated Steam.**

Effect of Superheated Steam Upon the Tensile Strength of Alloys. J. L. Hall. An account of experimental investigations, descriping methods employed and giving results obtained with two alloys of copper. Ill. 1400 w. Metallographist—Jan., 1903. No. 53129 F.

**U. S. Mint.**

Coining at the New Mint at Philadelphia. Joseph V. Woodworth. A brief description of the different processes. 3200 w. Am Mach—Jan. 8, 1903. No. 52788.

The Mechanical Heating Processes in the New United States Mint at Philadelphia. States the advantages derived from the use of gas as a fuel in the principal departments, and gives illustrated descriptions of the plant, machines, processes, etc. 3000 w. Am Mach—Jan. 22, 1903. No. 53071.

**Valve Gears.**

Double Slide Valve Gears for Steam Engines (Doppelschiebersteuerungen fur Dampfmaschinen). B. Stein. A discussion of various forms of cut-off gear operating by one valve sliding on or in another, with especial reference to the piston-valve engine of Haniel & Lueg. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing —Jan. 3, 1903. No. 53202 D.

Setting the Valves of the McIntosh & Seymour Engine. Illustrated detailed description. 1800 w. Power—Jan., 1903. No. 52799 C.

**Valves.**

Large Stop Valves for High-Pressure Steam. J. Hamilton Gibson. Read before the N. of England Inst. of Engrs. and Shipbuilders. Abstract. Gives a brief illustrated description of a new valve, or rather an altered valve, and its successful working. 1200 w. Col Guard—Dec. 24, 1902. No. 52682 A.

### MISCELLANY.

**Aeronautics.**

Aerial Navigation (Navigation Aérienne). Rodolphe Soreau. A critical study of the scientific principles involved in the resistance of the air, in balancing, supporting and the essentials of aerial navigation. An important paper. 20,000 w. Mem Soc Ing Civ de France—Oct., 1902. No. 53279 G.

**Heating and Ventilating.**

Heating and Ventilating by Forced Blast. Chas. L. Hubbard. A discussion of fans and blowers and their application to heating and ventilating systems. 3000 w. Am Elect'n—Jan., 1903. No. 53014.

Heating and Ventilating During the Past Twenty-five Years. W. J. Baldwin. Reviews the early history, naming those who aided the advancement, and the methods used. Principally considering steam. 3000 w. Eng Rec—Jan. 3, 1903. No. 52917.

**Mechanical Plant.**

Mechanical Equipment of the Macy Building, New York City. D. M. Quay. An illustrated description of the heating, ventilating and power plant of a modern mercantile building. 3000 w. Steam Engng—Jan. 10, 1903. No. 53043.

The New Mechanical Plant of the Mutual Life Building, New York. Illustrates and describes an extensive plant containing many features of interest. 4300 w. Eng Rec—Jan. 17, 1903. No. 53067.

# MINING AND METALLURGY

### COAL AND COKE.

**Belgium.**

The Coal Districts of Northern Belgium (Das Nordbelgische Kohlenworkommen). H. Mentzel. A review of the geology of Northern Belgium, with a sketch map showing the location of coal depotits. 1800 w. 1 plate. Glückauf—Dec. 27, 1902. No. 53238 D.

**Coal-Dust Explosions.**

The Origin of Coal-Dust Explosions. James Tinsley. Read before the Monmouthshire Colliery Officials Assn. Discusses the causes of these explosions, and urges that in mines yielding inflammable dust shot-firing be prohibited. 4300 w. Ir & Coal Trds Rev—Dec. 19, 1902. No. 52-702 A.

**Coal Trade.**

See Industrial Economy.

**Coal Washing.**

The Coal Washing Plant at the Wilczek Mine in Pollnisch-Ostrau (Die Kohlenwäscherei am Dreifaltigkeitsschachte in Polnisch-Ostrau). Hugo Hofer. Detailed description of a modern coal washing plant in Northern Austria. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 20, 1902. No. 53233 D.

**Coke.**

The Coke Industry. Fred C. Keighley. An explanation of the present situation due to inadequate transportation facilities, discussing some features of the trouble. 2500 w. Ir Age—Jan. 1, 1903. No. 52665.

**Colorado.**

The Trinidad or El Moro Coal Region of Colorado. Abstract of a monograph by Prof. R. G. Hills of U. S. Geol. Survey. Gives illustrated description of the geology of the region, its mines, etc. 2500 w. Mines & Min—Jan., 1903. No. 52960 C.

**Explosives.**

Explosives in Coal Mines. A New Order. Gives the order issued Dec. 20, 1902, revoking all other orders. 3000 w. Ir & Coal Trds Rev—Jan. 9, 1903. No. 53035 A.

**Production.**

Coal in 1902. Samuel Sanford, and other writers. Articles reviewing the whole production, and by districts, and matters that have affected the industry. 15000 w. Eng & Min Jour—Jan. 3, 1903. No. 52906.

**Screening.**

The Allard Coal-Screening Method. F. Esser, in *Glückauf*. Brief illustrated description. 500 w. Col Guard—Dec. 24, 1902. No. 52681 A.

**Waste.**

Prevention of Loss and Waste in Coal-Working. John Brown. 2nd Prize Essay. Considers the causes of waste and offers suggestions for economy. 4000 w. Ir & Coal Trds Rev—Dec. 19, 1902. No. 52701 A.

## COPPER.

**Assaying.**

The Copper Assay by the Iodide Method. Albert H. Low. From the *Jour. Am. Chem. Soc.* A description of the assay as now carried out, improvement in details leaving little to be desired on the score of accuracy. 1800 w. Eng & Min Jour—Dec. 27, 1902. No. 52889.

**Copper Industry.**

Copper as a Factor in Industrial Progress. James Douglas. Showing the importance of this branch of industrial wealth and giving information of interest. 1700 w. Ir Age—Jan. 1, 1903. No. 52669.

**Production.**

Copper in 1902. Articles by Frederick Hobart, James Douglas and other writers, reviewing the year's production, the markets, mining, etc. 5000 w. Eng & Min Jour—Jan. 3, 1903. No. 52895.

**Spain.**

The Rio Tinto Mines. Alfred Harvey. An illustrated description of these copper mines in Spain which have been worked hundreds of years. 1300 w. Min Rept—Jan. 22, 1903. No. 53134.

## GOLD AND SILVER.

**Assaying.**

Sources of Error in the Fire Assay of Gold and Silver Ores. P. G. Morgan. Calls attention to the various sources of error, avoidable and unavoidable, discussing their probable amount and the remedies. 5800 w. N Z Mines Rec—Nov. 17, 1902. No. 52609 B.

**California.**

Recent Developments on the Mother Lode. Ernest R. Woakes. Shows what is being done in Amador County and vicinity to make the low-grade gold ore pay when occurring at depths of 2000 ft. and over. 2000 w. Eng & Min Jour—Jan. 24, 1903. No. 53160.

**Cyanide Process.**

A Review of the Cyanide Process in the United States During 1902. Charles H. Fulton. Reviews the progress in each state, showing more extended application and improvement of details. 7800 w. Eng & Min Jour—Jan. 3, 1903. No. 52900.

Collecting Pyritic Material for Cyanide Treatment. Edgar Smart. An illustrated article supplementary to previous papers on "Developments in Cyanide Practice." 1000 w. Page's Mag—Jan., 1903. No. 53111 B.

Use of Lime as an Alkaline Reagent in Cyaniding. Ernest Gayford. An account of tests made at the Mercur Mill, Manning, Utah, to ascertain the cause of the abnormal consumption of cyanide, giving results. 1200 w. Min & Sci Pr—Jan. 3, 1903. No. 52952.

**Drainage.**

The Cripple Creek, Colo., Drainage Tunnel. W. B. Wilson. Describes this district, the water occurrence, and discusses the steps necessary to solve the water question, and the vast issues at stake. 3000 w. Min & Sci Pr—Jan. 17, 1903. No. 53136.

**Drift Mining.**

An Experience in Drift Mining in Hard Cement Gravel. L. H. Carver. Describes the methods employed in the operation of a drift mine in Calaveras Co., Cal. Maps. 1500 w. Min Sci Pr—Jan. 3, 1903. Serial. 1st part. No. 52953.

**Electric Refining.**

See Electrical Engineering, Electrochemistry.

**Gold Dredging.**

The Development of Gold-Dredging in the United States. Ralph L. Montagu, in *Mining Journal*, London. A comparison with New Zealand methods and costs. 2800 w. N Z Mines Rec—Dec. 16, 1902. No. 53094 B.

**Gold Fields.**

Yorkey's Goldfield, and the Marodian Gold and Copper Field. Lionel C. Ball. Gives the history, geology, topography, etc., and describes various mines in and near these fields. 7300 w. Queensland

Gov Min Jour—Nov. 15, 1902. No. 52734 B.

**Kalgoorlie.**

Metallurgical Methods at Kalgoorlie, W. A. E. Barton Hack. Reviews some of the different methods of extracting gold from the refractory ores. 2200 w. Eng & Min Jour—Jan. 24, 1903. No. 53161.

**Localization.**

An Example of the Localization of Rich Ore. T. A. Rickard. Facts collected in regard to the Independence mine, in the Cripple Creek District, principally. Ill. 1800 w. Eng & Min Jour—Dec. 27, 1902. No. 52890.

**Nevada.**

The Geologic and Economic Aspect of Tonopah, Nevada. Describes the unusual conditions of this mining district, which gives promise of proving a large producer of bullion. 1800 w. Min & Sci Pr—Jan. 10, 1903. No. 53063.

**New Mexico.**

New Mexico Mines in 1902. Charles R. Keyes. Review of a very prosperous year, and of the work of the different mines yielding gold, silver, copper, lead, zinc and other minerals. 1800 w. Eng & Min Jour—Jan. 17, 1903. No. 53064.

**Ontario.**

The Eastern Ontario Gold Belt. Prof. Willet G. Miller. Abstract of a paper in the Report of the Ontario Bureau of Mines. Describes the geology of the district and the gold deposits. 1000 w. Eng & Min Jour—Dec. 27, 1902. No. 52891.

**Placers.**

Summit County Placers of Colorado. Prof. Arthur Lakes. An illustrated description of the great hydraulic works now nearing completion near Breckenridge. 2500 w. Mines & Min—Jan., 1903. No. 52956 C.

**Production.**

The Production of Gold and Silver in the World During 1902. Reviews by Joseph Struthers, J. O. Heimberger, J. W. Neill, and others in regard to the production of various districts. 10500 w. Eng & Min Jour—Jan. 3, 1903. No. 52896.

**Sampling.**

Notes on Mine Sampling of the Main Reef Series. D. J. Williams. Considers the methods in use and the equipment needed, sectional drawings and points of importance. Ill. 5500 w. Jour Chem & Met Soc of S Africa—Oct., 1902. No. 52984 E.

**Sluicing.**

Sluicing for Gold in Queensland. Describes the system of working on the Russell goldfield. Ill. 2800 w. Queensland Gov Min Jour—Nov. 15, 1902. No. 52733 B.

**Smelting.**

The Economic Use of Petroleum Oil Gas Furnaces as Applied to Smelting, Laboratory Work, and Drill Heating. David Laird. On the adaptability of these furnaces for metallurgical work, treating them purely from a mechanical point of view and showing their advantages in certain kinds of work. 5300 w. Jour Chem Met Soc of S Africa—Oct. 1, 1903. No. 52985 E.

The Lead Smelting of Zinc Gold Slimes. P. S. Tavener. A full description of the writer's method of smelting zinc gold slimes with litharge, which appears to present advantages in economy and speed. Also describes the furnaces used. Ill. 11000 w. Jour Chem & Met Soc of S Africa—Oct., 1902. Discussion in Nov., 1902. No. 52983 each E.

The Use of Crude Oil in Smelting. Alfred von der Ropp. Abstract of a paper read before the California Miners' Assn. Setting forth the economy and advantages derived from the use of this fuel. 1600 w. Eng & Min Jour—Jan. 10, 1903. No. 52968.

**South Africa.**

Gold Mining in South Africa in 1902. W. Fischer Wilkinson. A short review of events previous to this year and their effects, with report for the last year. 2400 w. Eng & Min Jour—Jan. 3, 1903. No. 52897.

**Stamp Milling.**

Stamp Milling and Amalgamation of Free Gold Ores. Dana Harmon. The first of a series of articles giving the writer's methods and conclusions on the treatment of ores. 2500 w. Min & Sci Pr—Jan. 17, 1903. Serial, 1st part. No. 53137.

## IRON AND STEEL.

**Bertrand-Thiel.**

Notes on the Bertrand-Thiel Process (Betrachtungen über das Bertrand-Thiel Verfahren). A. Ledebur. With tables and diagrams showing the action at successive stages of the process. 2500 w. Stahl u Eisen—Jan. 1, 1903. No. 53254 D.

**Blowholes.**

The Influence of Chemical Composition Upon the Formation of Blowholes in Low Steel Ingots (Der Einfluss der Chemischen Zusammensetzung auf die Blasenbildung in Flusseisenblöcken). Axel Wahlberg. A review of the investigations of Brinell, collecting his results into diagrams. 2500 w. Stahl u Eisen—Jan. 1, 1903. No. 53256 D.

**Briquetting.**

Briquetting:—Its History, Value and

Possibilities in the Iron Industry. Henry S. Mould. Reviews the history of briquetting iron ores and the writer's experience in the work, some of the difficulties encountered and the present success, with advantages claimed. Discussion. Ill. 6600 w. Pro Engrs Soc of W Penna—Nov., 1902. No. 53036 D.

**Cast Iron.**

Some Unusual Crystals of Cast Iron. J. E. Johnson, Jr. Illustrates some interesting crystals, giving their analysis and an account of their origin. 1700 w. Metallographist—Jan., 1903. No. 53131 F.

**Desulphurizing.**

Manganese Ore as a Desulphurizing Material in the Basic Open-Hearth Process (Manganerz als Entschwefelungsmittel beim Basischen Martinverfahren). A. Riemer. Data and results of experience at the Pastuchoff Iron Works, Sulina, Russia, showing the extent to which the use of manganese ore carried the sulphur into the slag. 2000 w. Stahl u Eisen—Dec. 15, 1902. No. 53252 D.

**Electric Power.**

See Electrical Engineering, Power Applications.

**Electric Smelting.**

See Electrical Engineering, Electrochemistry.

**Hematite.**

The Parapara Hematite Deposits. Extracts from Geological Survey reports, giving information in regard to these deposits and their probable origin and value. 3800 w. N Z Mines Rec—Dec. 16, 1902. No. 53093 B.

**Iron Trade.**

See Industrial Economy.

**Ontario.**

Types of Iron-Bearing Rocks in Ontario. A. P. Coleman. Brief descriptions of the types of iron ore deposits found in the province. 900 w. Eng & Min Jour—Dec. 27, 1902. No. 52888.

**Open-Hearth.**

Open-Hearth Steel Plant of the American Steel Casting Co., at Alliance, Ohio. From a description prepared by L. L. Knox. Gives general features, construction of furnaces, etc. Ill. 2500 w. Foundry—Jan., 1903. No. 52641.

**Ore Handling.**

Modern Handling of Iron Ore on the Great Lakes. Jas. N. Hatch. Describes modern methods of mining and transportation during the last fifty years in the territory between the Lake Superior iron mines and the Pittsburg iron district. Ill. 12000 w. Jour W Soc of Engrs—Dec., 1902. No. 52659 D.

**Production.**

Iron and Steel in 1902. Articles by Frederick Hobart and others, reviewing the enormous production of the year and matters of related interest. 9500 w. Eng & Min Jour—Jan. 3, 1903. No. 52905.

**Prussia.**

The Iron Industry of the Siegerland. An illustrated historical account of this district in regard to the iron industry. There are 21 works, with 33 blast furnaces, with an annual output of about 700,000 tons of pig iron. 2200 w. Ir & Coal Trds Rev—Dec. 12, 1902. No. 52700 A.

**Rolling Mill.**

The Rolling Mills of the Differdingen Iron Works (Die Walzwerkanlage der Deutsch-Luxembergischen Bergwerks, Differdingen). With numerous views of the various departments of the works. 1800 w. Stahl u Eisen—Jan. 1, 1903. No. 53257 D.

**Russia.**

The South Russian Iron Industry. Archibald P. Head. Gives results of recent investigations of these industries, having had exceptional facilities for examining them from a metallurgical as well as a commercial standpoint. Maps, illustrations and discussion. 8000 w. Jour Soc of Arts—Dec. 19, 1902. No. 52619 A.

**Steel Analysis.**

Should Analysis Be Included in Steel Specifications? Extracts from an article by Herr Knaudt in *Stahl und Eisen*, with remarks. 1400 w. Ir Age—Jan. 8, 1903. No. 52674.

**Steel Castings.**

Annealed Steel Castings (Temperstahlguss). Bernard Osann. A description of the plant and methods of the Gelsenkirchen works, the largest establishment in Germany for the production of steel castings. 5000 w. Stahl u Eisen—Jan. 1, 1903 No. 53253 D.

**Steel Works.**

The Duquesne Works of the Carnegie Steel Company. The present article gives an illustrated description of the open-hearth plant and the blooming and 14-inch Morgan continuous mills. 3500 w. Ir Age—Jan. 1, 1903. Serial, 1st part. No. 52666.

**Steel.**

On the Simultaneous Presence of Ferrite and Cementite in Steel. E. F. Lange. A critical note, showing that the statement that "structurally free ferrite and structurally free cementite never exist together in the same steel." is incorrect. 1500 w. Metallographist—Jan., 1903. No. 53130 F.

Unexplained Phenomena in Steel.

Translated from the *Journal de l'Electrolyse.* States some of the peculiarities whose causes are yet unknown, and the need of employing the pyrometer and the microscope in its manufacture. 1400 w. Am Mfr—Jan. 22, 1903. No. 53127.

**Sulphur.**

Sulphide of Iron: Its Properties and Its Conditions in Iron. H. Le Chatelier and M. Ziegler in *Bull Soc d'Encour.* A study of the relations of sulphur with iron and manganese. Ill. 4000 w. Metallographist—Jan., 1903. No. 53132 F.

## MINING.

**Argentine.**

The Mines of Argentina. R. B. Brinsmade. An account of the adaptation, by the natives, of the methods of working to the requirements and limitations of the country. 5000 w. Mines & Min—Jan., 1903. No. 52962 C.

**Australasia.**

The Mining Industry of Australasia in 1902. F. Danvers Power. Reports a year of depression on account of low price of metals and prevailing drought. Reviews the year. 3800 w. Eng & Min Jour—Jan. 3. 1903. No. 52899.

**British Columbia.**

The British Columbian Mining Industry of 1902. Review of the operations of the past year giving an approximate estimate of the production of gold, silver, lead, copper, coal and other minerals. Ill. 4300 w. B C Min Rec—Jan., 1903. No. 52966 B.

**Deep Mines.**

Earth Pressures in Deep Mines. Considers that it is probable that at great depths pressures will be encountered that the timbering necessary to resist them will become an item of great expense. 2200 w. Col Guard—Jan. 2, 1903. No. 52947 A.

**Education.**

The Training of a Mining Engineer. R. A. S. Redmayne. Read before the So. Staffordshire and E. Worcestershire Inst. of Min. Engrs. A comparison of the present status of colliery managers with the position and requirements of those in the early history of the coal trade, showing the ever growing necessity for further scientific education. 4000 w. Col Guard—Dec. 19, 1902. No. 52679 A.

**Electric Power.**

See Electrical Engineering, Power Applications.

**Explosives.**

The Testing of Explosives in Belgium. An account of a new testing station for explosives recently fitted up by the Belgian Administration des Mines, for the investigation of the behavior of explosives under all conditions likely to occur in practice. 1800 w. Col Guard—Jan. 9, 1903. No. 52994 A.

The Theory of Missfires and Some Conclusions of Practical Value. E. H. Weiskopf. Considers missfires occurring with nitroglycerine explosives. 3200 w. Jour Chem & Met Soc of S Africa—Nov., 1902. No. 52979 E.

**Fans.**

Centrifugal Fans. Charles H. Innes. A study of laws, of service in the designing and affecting the efficiency of fans; the measuring of the work done by a fan, etc. Ill. 2500 w. Prac Engr—Jan. 16, 1903. Serial. 1st part. No. 53092 A.

**Haulage.**

Underground Wire Rope Haulage. Gives illustrated descriptions of features of the tail rope system as operated in the workings of a mine in Illinois. 1700 w. Sci Am Sup—Dec. 27, 1902. No. 52769.

**Hydraulic Mining.**

Proposed Retaining Barriers for the Débris from Hydraulic Mining in the Yuba River, Cal. Brief description of the methods adopted by the California Débris Commission. Ill. 1400 w. Eng News—Jan. 15, 1903. No. 53053.

**Idaho.**

The Bellevue Mining District of Idaho. Prof. Arthur Lakes. Illustrates and describes the geological peculiarities of the veins as shown in the Minnie Moore and the Queen of the Hills mines. 1800 w. Mines & Min—Jan., 1903. No. 52961 C.

**Mine Pumping.**

The "Dense Air" System of Power Transmission in Deep Mine Pumping. D. A. McNeill. Illustrated description of a plant recently installed at the Bisbee West Copper Min. Co.'s Shaft No. 1, which uses air as a means of power transmission. 800 w. Eng & Min Jour—Dec. 27, 1902. No. 52893.

**Mining Management.**

The General Management of Metalliferous Mines. Albert Williams, Jr. Mr. Williams's second paper discusses the important question of the relations between the technical and business departments showing the conditions tending to greatest commercial efficiecy. 3500 w. Engineering Magazine—February, 1903. No. 53291 B.

**Ore Deposits.**

Redcliffe Ore Deposits. Prof. Arthur Lakes. Describes the characteristics of these deposits which are not unlike in some respects to the ore deposits of the Mancos Contact and the American Nettie at Ouray. 1000 w. Mines & Min—Jan., 1903. No. 52959 C.

**Ore Dressing.**

Static Electricity Applied to Ore Dressing. W. G. Swart. Illustrates and describes a method of ore separation which consists in bringing the ore particles into contact with a statically charged metallic surface, the separation being effected by the difference of conductivity. The invention of Lucien I. Blake and Lawrence N. Morscher. 1300 w. Eng & Min Jour—Jan. 24, 1903. No. 53159.

The Highland Ore Dressing Mill, British Colombia. Ernest R. Woakes. Abstract of a paper read before the Inst. of Min. & Met., London. An illustrated description of the plant. 1200 w. Eng & Min Jour—Dec. 27, 1902. No. 52892.

**Power Distribution.**

Various Methods of Conveying Power to the Interior of Mines. T. Lindsay Galloway. Read before the Glasgow Univ. Engng. Soc. Describes briefly some of the systems which have been applied in mines, indicating why different methods have found suitable spheres of application. 3200 w. Col Guard—Jan. 9, 1903. Serial. 1st part. No. 52992 A.

**Production.**

The Production of Minerals and Metals in the United States During 1902. Joseph Struthers. General review with table of statistics. 4400 w. Eng & Min Jour—Jan. 3, 1903. No. 52894.

**Rock Drills.**

The Rock Drill Question in 1902 (Die Gesteinbohrmaschinen frage im Jahre 1902). H. Drolz. A comparison of the relative merits of compressed air and electricity for operating rock drills, with data from recent experience. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 20, 1903. No. 53234 D.

**Shaft Sinking.**

Sinking a Shaft by Compressed Air. Bergassessor Lüthgen, in *Glückauf*. States the conditions and describes the work and the difficulties encountered. Ill. 1800 w. Col Guard—Jan. 9, 1903. No. 52993 A.

Sinking by the Freezing Method at Washington, County Durham. Mark Ford. Abstract of a paper read before the N. of England Inst. of Min. & Mech. Engrs. Detailed description of sinking through alluvial deposits to the stone-head. 2500 w. Ir & Coal Trds Rev—Dec. 19, 1902. No. 52703 A.

**Timbering.**

Lining Galleries Exposed to Heavy Rock Pressure. Bergassessor Jacob, in *Glückauf*. Illustrates and describes the method adopted in the Neumehl pit. The galleries were lined with closed U-iron rings. 600 w. Col Guard—Dec. 12, 1902. No. 52677 A.

Mine Timbering in the Old Ironsides and Knob Hill Mines. H. P. De Pencier. Briefly describes these mines in British Columbia, which require an extensive system of timbering. 3700 w. Min & Sci Pr—Dec. 20 & 27. Serial. 2 parts. No. 52775.

The Working of Seams and Faults in Coal Measures (Studien über das Auftreten von Schnitten und Schlechten in der Kohle). H. Fleck. A description of the methods of timbering employed in the Shamrock mine at Wanne in the Ruhr district. 2000 w. 4 plates. Glückauf—Jan. 3, 1903. No. 53239 D.

**Winding.**

Winding Ropes in Belgium. Abstract of the results of an inquiry into the conditions of service of winding ropes in Belgian Collieries, both in regard to Manilla hemp and steel ropes. 2500 w. Col Guard —Jan. 16, 1903. No. 53079 A.

## MISCELLANY.

**Nickel.**

The Canadian Nickel Industry. An editorial discussing the general situation of the nickel industry, especially in Canada. 2000 w. Engng—Jan. 9, 1903. No. 53-026 A.

The Sudbury Nickel Mines. A. McCharles. Reviews events affecting the nickel mining industry. 1700 w. Eng & Min Jour—Jan. 3, 1903. No. 52901.

**Quicksilver.**

The Terlingua Quicksilver Deposits of Texas. B. F. Hill. Describes these deposits, methods of mining, etc. Ill. 1600 w. Min & Sci Pr—Jan. 17, 1903. Serial. 1st part. No. 53138.

**Tin.**

Notes on Tin Mining in Bolivia. J. B. Minchin. Information concerning the deposits and their mining, concentration, etc. 1400 w. Eng & Min Jour—Jan. 3, 1903. No. 52903.

Tin Deposits of the York Region, Alaska. Edgar Rickard. Discusses the geology and economic conditions. 1000 w. Eng & Min Jour—Jan. 3, 1903. No. 52902.

The Briseis Tin Lead at Derby, Tasmania. Edgar Rickard. Describes this district, the deposits, the difficulties met in the recovery of the tin, methods adopted, etc. Map. 1800 w. Eng & Min Jour—Jan. 17, 1903. No. 53065.

**Zinc.**

Zinc in 1902. Articles by Joseph Struthers, Walter Ranton Ingalls and Frank Nicholson reviewing the progress of the zinc industry. 5200 w. Eng & Min Jour—Jan. 3, 1903. No. 52904.

# RAILWAY ENGINEERING

## MOTIVE POWER AND EQUIPMENT.

### Braking.

The Hibbard Valve for Braking Empty and Loaded Cars. An illustrated description of a device which has been in service for some time on the Burlington & Missouri Rivers. 2000 w. R R Gaz—Jan. 23, 1903. No. 53172.

### Car Mountings.

Manufacture of Car Mountings at the Shops of the Eastern Railway of France at Mohon (Fabrication des Ferrures aux Ateliers de la Cie d'Est à Mohon). L. Tolmer. A very complete account of the works and tools for the production of the metallic parts of railway cars, showing the processes in detail. 10,000 w. Revue de Mécanique—Dec. 31, 1902. No. 53272 E +F.

### Coaling.

Modern Methods of Coaling Locomotives. An illustrated description of the Mt. Pleasant coaling station, of the St. Louis Southwestern Ry. system. 1100 w. Ry & Engng—Dec. 27, 1902. No. 52867.

### Couplers.

Automatic Couplers for Railway Cars Selbstthatige Kuppelungen für Eisenbahnfahrzeuge). Ernst Sauer. A discussion of the adaptability of the standard couplers of the American Master Car Builders' Association, in connection with the existing screw couplers of Germany. 7000 w. Glasers Annalen—Dec. 15, 1902. No. 53226 D.

### Draft Gear.

The Essentials of a Good Draft Gear. E. M. Herr. Defines the term "draft gear" and discusses as essentials, the draw bar, adjustable yielding resistance, and fixed attachments. 1200 w. Pro of Ry Club of Pittsburg—Dec. 26, 1902. No. 53069.

The Essentials of a Good Draft Gear. Roy V. Wright. Considers some of the essentials to be a capacity of at least 100,000 pounds; a draw-bar movement of at least two inches; small amount of recoil; simple and substantial design. 700 w. Pro of Ry Club of Pittsburg—Dec. 26, 1902. No. 53070.

### Locomotive Boilers.

Evolution of the Locomotive Boiler. O. H. Reynolds. A review of the progress during the last 100 years. Ill. 2000 w. Loc Engng—Jan., 1903. No. 52743 C.

The Dimpfel Boiler. C. H. Caruthers. Brief illustrated description of a type built in 1856. 900 w. Loc Engng—Jan., 1903. No. 52744 C.

The Explosion of Modern Locomotive Boilers. Considers faulty design as a contributing cause in connection with low water. 1500 w. Ry Age—Jan. 2, 1903. No. 52757.

### Locomotive Construction.

The Building of an American Locomotive. Frank H. Fayant. An illustrated account of standard locomotive construction in the United States, based upon practice in the Baldwin works at Philadelphia. 5000 w. Page's Mag—Jan., 1903. No. 53110 B.

### Locomotives.

A Curious Locomotive. Brief illustrated description of a design of Mr. Michael Reynolds, patented in 1895. 450 w. Engr, Lond—Jan. 16, 1903. No. 53088 A.

Consolidation Locomotive of the Chicago Terminal Transfer Railroad. Illustrates and describes locomotives designed to meet the unusual requirements of the switching service about the Chicago terminals. 400 w. Ry Age—Dec. 26, 1902. No. 52755

Four-Cylinder Balanced Compound Locomotives. Designs and extracts from two letters received by W. F. M. Goss, giving suggestions for new designs of balanced engines and the advantages claimed. Ill. 700 w. R R Gaz—Jan. 2, 1903. No. 52924.

Göldsdorf Compound Locomotives. Reginald Gordon. An illustrated article stating some of the advantages claimed by this system. 1400 w. R R Gaz—Jan. 16, 1903. No. 53058.

Heavy Compound Freight Locomotives. Illustrated description of the heavy Vauclain compounds, the 2-8-2 (Mikado) type, building for the Atchison, Topeka & Santa Fe Ry. 300 w. Am Eng & R R Jour—Jan. 1903. No. 52854 C.

Narrow-Gauge Locomotive for Indian States Military Light Railways. Ilustration with brief description. 400 w. Engng—Dec. 26, 1903. No. 52692 A.

New Canadian Pacific Passenger Locomotives. Drawings and description. 600 w. Ry Age—Dec. 19, 1902. No. 52751.

Side Tank Switching Locomotive for the Kanawha and Michigan. Illustrated description of an engine of the "Calumet" type designed to work on 4 and 4½ per cent. grades. 1500 w. Ry Age—Jan. 2, 1903. No. 52758.

Ten-Wheel Passenger Locomotive. Canadian Pacific. Illustrated description of new engines with features of interest. 500 w. R R Gaz—Jan. 2, 1903. No. 52925.

The Growth of the Locomotive. Angus Sinclair. The first of a series of illustrated articles reviewing the development, the first locomotives to run upon rails having been built 100 years ago. 3500 w. Loc Engng—Jan., 1903. Serial. 1st part. No. 52740 C.

**Rolling Stock.**

Railway Rolling Stock at the Düsseldorf Exposition (Eisenbahn Fahrbetriebsmittel auf der Aussfellung in Düsseldorf 1902). Berthold Braun. Giving illustrated descriptions of cars for steam and electric railways exhibited at Düsseldorf. 6000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Dec. 26, 1902. No. 53224 B.

**Safety Device.**

New Safety Device for Railways. Illustrates and describes the construction and method of operation of an electric device for preventing collisions. 1000 w. U S Cons Repts, No. 1543—Jan. 13, 1903. No. 52778 D.

**Spark Arrester.**

The Development of the Locomotive Spark Arrester. J. Snowden Bell. Considers the leading and characteristic features of the development. Ill. 2200 w. Loc Engng—Jan., 1903. No. 52741 C.

**Train Lighting.**

Steam Dynamo for Electric Train Lighting (Versuche mit einer Dampf-dynamo für Elektrische Beleuchtung von Eisenbahnzugen). A description of the Schichau-Schuckert machine, a small generating set placed on the locomotive, operating in connection with a storage battery. 1000 w. Glasers Annalen—Dec. 15, 1902. No. 53227 D.

Systems of Electric Train Lighting (Einige Systeme Elektrischer Zugbeleuchtung). Hans Dominik. Describing especially the systems of Vicarino and of Kull, using dynamos driven from the car axle. 3000 w. Ill. Zeitschr f Klein a Strassenbahnwesen—Jan. 1, 1903. No. 53286 D.

## PERMANENT WAY & BUILDINGS.

**Cattle-Guards.**

The Cattle-Guard Question in Canada. Gives the conditions to regulate the types of guard, submitted by a specially appointed commission, and the changes proposed in location and arrangements. 1100 w. Ry & Engng Rev.—Jan. 3, 1903. No. 52869.

**Grades.**

Virtual Grades for Freight Trains. Discussion of a paper by A. C. Dennis. 2800 w. Pro Am Soc of Civ Engrs—Dec. 1902. No. 52633 E.

**Oregon Short Line.**

Improvements on the Oregon Short Line. Illustrated account of important new construction on this branch of the Union Pacific system. 1400 w. Ry Age —Dec. 26, 1902. No. 52754.

**Rutland—Canadian.**

The Rutland-Canadian Railway and Its Structures. John W. Burke. Illustrated description of this section of the Rutland R. R., its bridges, culverts, lake embankments, etc. 2800 w. Eng News—Jan. 15, 1903. No. 53050.

**Shops.**

New Locomotive Shops. The present article gives an illustrated general description of the new shops of the Philadelphia & Reading Ry., at Reading, Pa. 1600 w. Am Engr & R R Jour—Jan., 1903. Serial. 1st part. No. 52853 C.

**Signals.**

A Study of Some Interlocking Switch Systems. (Etude de Quelques Appareils Destinés à ne Libérer les Enclenchements qu' apres l'Achèvement des Mouvements). MM. Cossmann & Cuny. A description of the improved electrically operated interlocking system used in the train yard of the Gare du Nord at Paris. 6000 w. 2 plates. Rev Gen des Chem de Fer—Jan., 1903. No. 53231 H.

Pneumatic Signalling on the London and South-Western Railway. Illustrates and describes a plant on the low-pressure pneumatic system at Salisbury. 1500 w. Engr, Lond—Dec. 19, 1902. No. 52698 A.

Railway Block Signalling. J. Pigg. A well-illustrated paper, read before the Newcastle section of the Institution of Electrical Engineers, on block signalling, with particular reference to British practice. 7000 w. Elec Engr, Lond, (Supplement)—Jan. 2, 1903. No. 52821 A.

Recent Development of Block and Interlocking Signal System. W. H. Elliott. A review of recent changes made both from the standpoint of the trainmen, and from the standpoint of the signal engineer. 2000 w. Loc Engng—Jan., 1903. No. 52742 C.

**Terminals.**

Grand Central Station Improvements and Connection with Rapid Transit Subway. Brief illustrated account of the extensive improvements proposed for this terminal in New York, and of the Park Ave. tunnel. 1200 w. Sci Am—Jan. 17, 1903. No. 53044.

The New York Central's Terminal Proposition. An illustrated outline of the improvements suggested for the Park Ave. tunnel and a plan for the removal of a number of grade crossings. 1600 w. Ry Age—Dec. 19, 1902. No. 52750.

The New York Terminal of the Pennsylvania Railroad. Information from an official statement in regard to this proposed work. 1200 w. R R Gaz—Jan. 16, 1903. No. 53060.

### TRAFFIC.

**Per Diem.**

The Operation of the Per Diem System of Settlement for Car Hire. Papers on this subject by M. B. Casey and by W. H. Rosevear, with discussion by members. 12300 w. N Y R R Club—Dec. 19, 1902. No. 52955.

**Rates.**

Legislative Regulation of Railroad Rates. Walker D. Hines. Presented at Philadelphia meeting of the Am. Econ. Assn. Discusses the question of enlarging the powers of the Interstate Commerce Commission by giving it the power to make rates and regulations for interstate traffic. 5400 w. Ry Age—Jan. 2, 1902. No. 52759.

Live Stock Rates Between Chicago and the Missouri River. A. B. Stickney. An argument made before the Interstate Commerce Commission in the case of the Chicago Live Stock Exchange vs. the A., T. & S. F. Ry. Co. and others. 14000 w. Ry Age—Jan. 23, 1903. No. 53141.

National Regulation of Railways. Charles A. Prouty. Abstract of a paper before the Philadelphia meeting of the Am. Econ. Assn. Suggests the creation of a commerce court and outlines the work belonging to it. 1300 w. Ry Age—Jan. 2, 1903. No. 52760.

Scientific Rate Making. Suggests a scheme of rate schedules. 2700 w. Ry Age—Dec. 26, 1902. No. 52753.

Senator Cullom on Pooling Legislation. From the Chicago *Tribune*. Considers that Congress has authority to grant the railroads permission to pool. 900 w. Ry Age—Jan. 2, 1903. No. 52761.

## STREET AND ELECTRIC RAILWAYS

**Accounting.**

Street Railway Accounting. J. F. Calderwood. A discussion by different authors, of "Distribution of the Discount Credit," "Standard Form of Report," "Advantages of the Car Hour," and "Computation of the Loss from Transfers." 3500 w. St Ry Jour—Jan. 3, 1903. No. 53101 D.

**Accumulator Traction.**

Accumulators in Electric Traction. A discussion, with formulae, of the advantages of a combined accumulator and trolley or conduit system, the accumulators being charged on that part of the line equipped with wires, and driving the car the rest of the way. 1400 w. Elec Engr, Lond—Jan. 9, 1903. No. 53126 A.

**Augusta & Aiken.**

The Augusta & Aiken Railway. An illustrated description of a 25-mile trolley road in Georgia and South Carolina, and its electrical equipment. 3000 w. St Ry Jour—Jan. 3, 1903. No. 53023 D.

**Birmingham, Ala.**

New Car House and Repair Shops of the Birmingham Railway, Light & Power Co., Birmingham, Ala. Illustrated description. 2000 w. St Ry Rev—Jan. 20, 1903. No. 53075 C.

**Brakes.**

Brakes for Electric Tram Cars. A discussion of the ways tramcars may be braked and the requirements of an ideal brake. 2300 w. Engng—Dec. 19, 1902. No. 52683 A.

**Chicago.**

Engineering and Operating Features of the Chicago Transportation Problem. An abstract of the report submitted by Bion J. Arnold giving facts regarding the conditions and matters of engineering interest. 5500 w. St Ry Jour—Jan. 10, 1903. Serial. 1st part. No. 53040 D.

Report on Chicago Street Railways. Report of B. J. Arnold on the engineering and operating features of the transportation problem, submitted to the Committee on Local Transportation. Maps and ill. 11800 w. St Ry Rev—Jan. 20, 1903. No. 53074 C.

**Commercial Management.**

Some Notes on the Commercial Management of Electrical Tramways. T. W. Sheffield. A discussion of the advantages of electric traction, particularly in the Manchester district, the carriage of freight, interurban traffic, etc., with tabulated opinions of various British engineers. Serial. Part I. 2500 w. Feilden's Mag—Jan., 1903. No. 53118 B.

**Control System.**

Train Unit Control System Used on the Berlin Elevated Railway. A description with diagrams, of a system of electric train control, installed by Siemens & Halske, in which only two motor cars per train can be used. 1000 w. St Ry Jour—Jan. 3, 1903. No. 53024 D.

**Electric Cars.**

Various Types of Cars for Electric Tramways (Different Types de Voitures Automotrices de Tramways Electriques). Gustave Lelarge. With illustrations of motors, controllers and trucks used on electric tramways in France. Serial. Part I. 10,000 w. 2 plates. Rev Gen des Chem de Fer—Jan., 1903. No. 53232 H.

**Electric Traction.**

Electric Traction on Main Line Railways (Ueber Elektrische Zugförderung auf Normalen Eisenbahnen). Br. Böhm-Raffay. A discussion of the practicability of applying electric locomotives to main line service. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 19, 1902. No. 53222 B.

**Engineering Hints.**

See Electrical Engineering, Generating Stations.

**Europe.**

The Possibilities for Capital in European Tramway Enterprises. A discussion of the features of urban and interurban passenger transportation in Europe, methods of obtaining franchises, and commercial possibilities of electric tramways. 5000 w. St Ry Jour—Jan. 3, 1903. No. 53022 D.

**Fault Localising.**

See Electrical Engineering, Measurement.

**Freight.**

Freight and Express. Alton D. Adams. Reasons why electric railways should take up freight and express business, with some statistics. 2500 w. St Ry Rev—Dec. 20, 1902. No. 53104 C.

**Hydrocarbon Motors.**

Applications of Hydrocarbon Motors to Traction Service (Anwendungen von Kohlenwasserstoffmotoren für Traktionszwecke). Illustrated description of internal combustion motors, using benzine or gasoline as fuel, in connection with tramway traction. 2000 w. Ill. Zeitschr f Klein u Strassenbahnwesen—Dec. 16, 1902. No. 53284 D.

**Inclined Ry.**

The Machinery for the Consett Iron Company's Garesfield and Derwenthaugh Inclined Railway. An illustrated description of the drum-house, drums, bed plate and brake gear. 1200 w. Ir & Coal Trds Rev—Dec. 26, 1902. No. 52704 A.

**Interurban.**

Middleboro, Wareham & Buzzards Bay Street Ry. An illustrated description of an interurban road in the Cape Cod region, which is of interest because of its original schemes and ways of doing things. 6300 w. St Ry Rev—Jan. 20, 1903. No. 53073 C.

**Kalgoorlie.**

Electric Railway Construction in Kalgoorlie. Illustrated description of the system installed in this mining city of Western Australia. 600 w. St Ry Jour—Jan. 24, 1903. No. 53144 D.

**Kingston.**

Kingston Consolidated Railroad Company. An illustrated description of a successful trolley road at Kingston and Rondout, N. Y., and its park at Kingston Point. 2500 w. St Ry Jour—Dec. 27, 1902. No. 53019 D.

**Lancashire.**

The Electrification of South West Lancashire. Describes the Farnworth and Kearsley Tramways. Ill. 5500 w. Tram & Ry Wld—Dec. 11, 1902. No. 52706 B.

**Line Car.**

Line Car at Atlanta, Ga. Illustrated description of a construction and repair car for an electric railway. 700 w. St Ry Rev—Dec. 20, 1902. No. 53105 C.

**Massachusetts.**

Steam and Trolley in Massachusetts. Clarence Deming. Discusses the trolleys of this state and their bearing upon the steam roads, the railway laws, and the problems to be solved. 4000 w. R R Gaz—Jan. 16, 1903. No. 53057.

**New Line.**

The South Wales and Bristol Direct Railway. Information and description of the leading characteristics of this line. Ill. 2800 w. Transport—Jan. 2, 1903. No. 52930 A.

**New York Traffic.**

The Passenger Traffic Problems of Greater New York. W. W. Wheatly. Discusses existing conditions, the transportation problem, facilities under construction, the additional facilities as outlined, with suggestions for improvement. Ill. 5000 w. St Ry Jour—Jan. 10, 1903. Serial. 1st part. No. 53039 D.

**Nottingham.**

Nottingham Corporation Tramways. Illustrates and describes recent work in connection with these tramways, new sections, new sheds, and repair shops. 3800 w. Tram & Ry Wld—Dec. 11, 1902. No. 52705 B.

**Ohio.**

Engineering Features of the Western

Ohio Railway. D. W. Pell. An illustrated description of power house, line and cars of an interurban electric railway centering at Lima, Ohio. 2200 w. St Ry Rev—Dec. 20, 1902. No. 53107 C.

**Outlook.**

The Outlook in Electric Traction in 1903. Dr. Louis Bell. A general review of present conditions in electric tramways and railways. 1800 w. Elec Wld & Engr —Jan. 3, 1903. No. 52830.

**Paris Conduit.**

The Extensive Paris System of Conduit Electric Roads. C. L. Durand. An illustrated description of the track construction and other features of the Paris electric conduit railways. 1800 w. Elec Rev, N Y—Jan. 10, 1903. No. 53008.

**Review.**

Electric Traction in 1902. Dr. Louis Bell. A general review. 3000 w. Elec Rev, N Y—Jan. 10, 1903. No. 53001.

**Rodez.**

The Electric Tramways of Rodez (Les Tramways Electriques de Rodez). H. Somach. General description of overhead trolley line in operation at Rodez in the south of France. 1800 w. 1 plate. Génie Civil—Dec. 27, 1902. No. 53210 D.

**Shops.**

New Shops for the Chicago City Ry. Illustrated description of street railway shops and their equipment. 2500 w. St Ry Rev—Dec. 20, 1902. No. 53103 C.

**Single Phase.**

See Electrical Engineering, Power Applications.

**Steam Car.**

A Steam Propelled Street Car. An illustrated description of a self-propelled car being built for use in Yucatan, Mexico. 1200 w. St Ry Jour—Jan. 10, 1903. No. 53041 D.

**Stopping.**

The Cost of Stopping. R. W. Western. An examination of the expenses involved in the stoppage of tramcars. 2500 w. Tram & Ry Wld—Dec. 11, 1902. No. 52707 B.

**Surface Contact.**

The Cruvellier Surface Contact System. Illustrated description of the application of this system to long-distance traveling, with three-phase current at 3000 volts. 1300. Engng—Jan. 2, 1903. No. 52936 A.

**Three-Wire.**

A Three-Wire Electric Railway System Operating Between Grenoble and Chapareillan (France). Enrico Bignami. An illustrated description of an electric railway and hydro-electric station. Continuous current is distributed over a three-wire system, with 1,200 volts between the outer wires, and the car motors are in series. 1800 w. Elec Rev, N Y—Jan. 10, 1903. No. 53005.

**Third Rail.**

Results with the Third Rail in Boston. A report of the operation of this extensive system, the construction and the problems in its working. Ill. 1500 w. Elec Wld & Engr—Jan. 24, 1903. No. 53165.

**Toledo & Western.**

Equipment of the Toledo & Western Railway. An illustrated description of the track and line construction, rolling stock and power plant of this important interurban electric road in Ohio. 3500 w. St Ry Jour—Dec. 20, 1902. No. 53016 D.

**Tri-City.**

System and Parks of the Tri-City Railway Co. An illustrated description of an electric railway between Davenport, Iowa, and Rock Island and Moline, Illinois, and its pleasure parks. 2200 w. St Ry Rev—Dec. 20, 1902. No. 53108 C.

**Trolley Poles.**

The Manufacture of Iron Masts (Fortschritte in der Herstellung Eisener Rohrmaste). Emil Bock. A discussion of the stresses and strains upon tubular masts used for trolley and electric light wires, with description of improved machinery for making poles. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 3, 1903. No. 53204 D.

**Trolley Wagons.**

Electric Trolley Wagons and Omnibuses. Frank C. Perkins. Illustrates and describes a system of transportation gaining favor in French and German cities in streets where it is impossible to install tramways. 700 w. Sci Am—Jan. 3, 1903 No. 52772.

**Trunk Lines.**

Long-Distance Electric Railroading. Louis Duncan. Discusses the application of electricity to traction on tramways, suburban and interurban roads, and the field at present occupied by steam locomotives, reviewing the systems, and showing the methods now used are not applicable on steam roads, but thinks the problem will yet be solved. 3800 w. Tech Quar—Dec., 1902. No. 52949 E.

**Vienna.**

Plan for the Extension of the Vienna Municipal Railway (Ein Vorschlag zur Erweiterung des Wiener Stadtbahnnetzes). H. v. Feyrer. A study of the requirements of traffic upon the elevated railway of Vienna with a plan for extending the lines. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 19, 1902. No. 53223 B.

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## THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist & Metallurgist. *m.* London.

Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

# CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

**City Transportation.**

Report on the Engineering and Operating Features of the Chicago Transportation Problem Submitted to the Committee on Local Transportation of the Chicago City Council. By Bion Joseph Arnold, M. S., M. Ph., E. E. Size, 9¼ by 6¼ in.; pp. 310; figures, 50; folding plates, 15. Paper binding. Fourteen maps in separate cover.

The problems of local transportation are becoming more and more complex in our great cities and the need for their satisfactory solution is daily growing more urgent. It is therefore, highly encouraging to see these problems discussed in a scientific, yet practical way by an expert engineer, who is hard-headed enough to realize the force of existing conditions, but who also has the breadth of mind to take a general view of the situation and to provide for the future. The present report was called forth by the confused and congested condition of local transportation in Chicago, particularly in the business district, which is confined to an area of about one square mile, in which all traffic converges. The report devotes most attention to the surface railway systems, but it also presents a plan for a unified combined surface and subway system, and discusses the general transportation situation as well as many of the details, and it will well repay most careful consideration by all who are interested in the questions with which it deals.

**Dies.**

Dies: Their Construction and Use for the Modern Working of Sheet Metals. By Joseph V. Woodworth. Size, 9¼ by 6 in.; pp. 384; illustrations, 505. Price, $3. New York: Norman W. Henley & Co.

This is a treatise on the design, construction and use of dies, punches, tools, fixtures and devices, together with the manner in which they should be used in the power press for the cheap and rapid production of sheet metal parts and articles. It shows fundamental designs and gives practical points by which sheet metal parts may be produced at the minimum of cost and with the maximum of output. The hardening and tempering of press tools and the use of files are described, and many styles of power press are well illustrated. The classes of work which may be produced to the best advantage by the use of dies in the power press are discussed by one who speaks with the authority of experience, and the book as a whole is an eminently practical one, written by a practical man for practical men.

**Illumination.**

The Art of Illumination. By Louis Bell, Ph. D. Size, 9 by 6 in.; pp. 345; illustrations, 127. Price, $2.50. New York: McGraw Publishing Co.

As is well said in the opening paragraph of this volume, its purpose is "to set forth some of the fundamental doctrines, optical, physiological, and aesthetic, which underlie the proper use of artificial illuminants, and to point out how they may be advantageously adapted to existing conditions." While there has been a great deal written about the production of light in its mechanical and scientific aspects, there is very little literature on its distribution and consumption, to borrow analogies from economics. Illumination, or the useful effect of light, is, however, now receiving more attention, and it has been the subject of discussion before the American Institute of Electrical Engineers. In one of these recent discussions the author of the present book took a prominent part, and the matter which he so ably handled there, has now been elaborated and enlarged into a most interesting volume. The efforts of inventors and engineers have been mainly exerted in the production of an artificial light of high mechanical efficiency, and other considerations, of equal, if not greater practical importance in the art of illumination, have been too often lost sight of. The fundamental principles of illumination: that "it must be amply adequate in amount, suitable in kind, and applied so as not to react injuriously upon the eye," are clearly set forth in this book, and their applications very interestingly described and illustrated. The possibilities of vastly better illumination, even with our present sources of light, are well brought out, while at the same time the author indicates the directions in which improvements in the sources of light themselves will probably be made.

**Railway Statistics.**

Fourteenth Annual Report on the Statistics of Railways in the United States for the Year Ending June 30, 1901. Prepared by Henry C. Adams, statistician to the Interstate Commerce Commission. Size, 9¼ by 6 in.; pp. 694. Map. Washington: Interstate Commerce Commission.

Among the most valuable results of the labors of the Interstate Commerce Commission are the statistics which are embodied in their reports, of which the present volume is the latest. Among the tables contained in the body of this report are those on the classification of railways and mileage; the amount of railway capital at the close of the year; earnings and income for the year; general expenditures; charges against income on account of railway capital, and general balance sheet. Preceding these tables is a discussion of them and also of other statistics concerning equipment, employees, public service of railways, taxes, accidents and various other matters. These reports are of the greatest importance for getting a correct understanding of the many and complex problems of the control and management of railways and, indeed, of other great corporations as well, and definite information such as this will help to determine to what extent the supervisory powers of the Interstate Commerce Commission may be applied to corporations other than railways, and how far the Government can advantageously carry its controlling functions without interfering harmfully with the efficiency and economy of individual management.

**Steam Power Plants.**

Steam Power Plants; Their Design and Construction. By Henry C. Meyer, Jr., M. E. Size, 9½ by 6 in.; pp. 160; illustrations, 65; plates, 16. Price, $2. New York: McGraw Publishing Co.

Part of the text of this volume appeared originally in *The Engineering Record* as a series of articles, which have now been thoroughly revised and have had considerable new matter added to them. The eleven chapters treat, respectively, of the design of steam power plants; proportioning steam boilers; design of tubular boilers and boiler specifications; selection of engines; specifications for steam engines; steam and water piping; condensers; feedwater heaters and economizers; mechanical draft; chimneys; coal handling, water supply and purification. The matter thus presented is of special value to owners or managers of manufacturing plants or buildings requiring power installations who are not themselves expert steam engineers, but who may be called upon to design or purchase a steam-power plant. Of course, the best procedure, under such circumstances, is to secure the services of a competent consulting engineer, but where this is not practicable, the present volume will be of great help in supplying sound information in a clear and attractive manner, and the expert himself will find in it many valuable facts and figures in accessible and convenient form.

**Steam Turbine.**

The Steam Turbine. By Robert M. Neilson. Size, 9 by 5½ in.; pp. 163; illustrations, 145; plates, 9. Price, 7s. 6d. ($2.50). London, New York and Bombay: Longmans, Green, and Co.

The steam turbine has lately come to the front with a rush. Although farsighted engineers have long recognized its possibilities and been impressed by some of its performances, to the general public and indeed, to the bulk of the engineering profession, it has been little more than a curious machine for propelling some small experimental vessel at phenomenal speeds. But now the merits of the steam turbine and its suitability for many purposes, on land as well as at sea, notably in driving electric generators, are becoming generally acknowledged, and it is eminently proper that there should be a book devoted to it, as its literature has heretofore been scattered through the pages of technical journals and the transactions of engineering societies. The present volume gives a general history of the steam turbine, traces the points of resemblance between it and other motors, discusses thermodynamic theory and some of the practical details of construction, describes the principal types of steam turbines in commercial use, gives the results of recent tests and tells of the application of the steam turbine to the propulsion of vessels. An appendix contains a list of the British patents relating to steam turbines from the earliest records up to the end of 1899, and an index completes a book which is timely, instructive and interesting.

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## BOOKS ANNOUNCED.

Design of Dynamos. By Silvanus P. Thompson, D. Sc., F. R. S. Price, 12s. 6d. ($3.50). New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

Hardening, Tempering, Annealing and Forging of Steel. By Joseph W. Woodworth. Price, $2.50. New York: Norman W. Henley & Co.

A Treatise on Roads and Pavements. By Ira Osborn Baker, C. E. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

An Elementary Treatise on the Mechanics of Machinery. By Joseph N. Le Conte. Price. $2.25. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

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